INSTRUCTION MANUAL

MODEL L-7100 PUMP

Read and keep this manual

- Read safety instructions carefully and understand them before starting your operation.
- Keep this manual at hand for reference.

HITACHI

INSTRUCTION MANUAL FOR MODEL L-7100 PUMP

PREFACE

The Model L-7100 pump is designed to deliver mobile phases in the liquid chromatograph system.
This instruction manual has been prepared for users of Model L-7100 pump. It describes the operation, checkup and maintenance procedures for the L-7100 pump.
The Model L-7100 is intended for use by persons having a basic knowledge of chemical analysis. Remember that improper use of the analytical instruments, chemicals or samples would result not only in wrong analytical data but also in consequences adverse to safety.
Read this instruction manual carefully before attempting operation. For proper use of this instrument, please acquaint yourself with it.

This instruction manual is applicable to the instruments having serial numbers 0707-189 upward (program product numbers 8107805-04 upward).

IMPORTANT

Warranty on Product

(1) Scope of Warranty

The Model L-7100 pump is warranted to be free from defects in material, workmanship and operation under normal use within the product specifications indicated in this manual for the period stated below. Liability under this warranty is limited to repair, adjustment or replacement by Hitachi or its approved representative.

Any parts which prove to be defective during the warranty period will be repaired, adjusted or replaced without charge. Note that a substitute part may be used for repair, or replacement with an equivalent product may be made instead of repair. Also, such system components as a personal computer and printer to be updated frequently for improvement may not be available in original versions at the time of replacement.

The warranty contained herein is for the benefit of and shall be enforceable by the original purchaser of this instrument and is not transferable.

Consumable parts and operating supplies are excluded from this warranty.

(2) Warranty Period

One year from the date of initial installation.

(In case that the separate warranty document has been issued, the warranty period indicated in it takes precedence over the above period.)

(3) Limitations and Exclusions on Warranty

Note that this warranty is void in the following cases:

(a) Failure due to operation at a place not meeting the installation requirements specified by Hitachi.

(b) Failure due to power supply voltage/frequency other than specified by Hitachi or due to power failure.

(c) Corrosion or deterioration of the tubing due to impurities contained in reagent, gas or cooling water supplied by the user.

(d) Corrosion of the electric circuits or deterioration of the optical elements due to highly corrosive atmospheric gas.

(e) Failure due to use of hardware, software or spare parts other than specified by Hitachi.

(f) Failure due to improper handling or maintenance by user.

(g) Failure due to maintenance or repair by a service agent not approved or authorized by Hitachi.

(h) Failure due to relocation or transport after initial installation.

(i) Failure due to disassembly, modification or relocation not approved by Hitachi.

(j) Failure due to acts of God, including fire, earthquake, storm, flood, lightning, social disturbance, riot, crime, insurrection, war (declared or undeclared), radioactive pollution, contamination with harmful substance, etc.

(k) Failure due to computer virus infection.

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NO ORAL OR WRITTEN INFORMATION OR ADVICE GIVEN BY HITACHI, ITS DEALERS, DISTRIBUTORS, AGENTS OR EMPLOYEES SHALL CREATE A WARRANTY OR IN ANY WAY INCREASE THE SCOPE OF THIS WARRANTY.

HITACHI ASSUMES NO LIABILITY FOR ANY DAMAGE TO DATA OR APPLICATION SOFTWARE DUE TO ANY POSSIBLE FAULT OR FAILURE OF THIS INSTRUMENT.

Installation, Relocation and After-Sale Technical Service

Installation of this instrument shall be carried out by or under supervision of qualified service personnel of Hitachi or its authorized service agent.

Before installation of this instrument, the customer shall make preparations for satisfying the installation requirements in accordance with this manual.

When relocation of this instrument becomes necessary after initial installation (delivery), please notify your local Hitachi sales representative or nearest Hitachi service office.

Technical support service for this instrument is available from a service agent approved or authorized by Hitachi within regular working hours on workdays.

Disposal of This Instrument

When disposing of this instrument, follow the relevant environmental protection regulations for your local requirement.

Other Precautions

(1) Handling of Chemicals and Samples

(a) The user is responsible for following relevant legal standards and regulations in the handling, storage and discarding of chemicals and samples used in analytical operations of this instrument.

(b) Reagents, standard solutions and accuracy-control samples shall be handled, stored and discarded as instructed by the respective suppliers.

(2) Notice on This Instruction Manual

(a) The information contained in this manual is subject to change without notice for product improvement.

(b) This manual is copyrighted by Hitachi with all rights reserved. No part of this manual may be reproduced or transmitted in any form or by any means without the express written permission of Hitachi.

⚠ SAFETY SUMMARY

⚠ General Safety Guidelines

Before using the L-7100 pump, carefully read the safety instructions given below.

- Operate the instrument according to the instructions in this manual.
- Be sure to observe the warnings indicated on the product and in the instruction manual. Failure to do so could result in personal injury or damage to the product.
- The hazard warnings which appear on the warning labels on the product or in the manual have one of the following alert headings consisting of an alert symbol and a signal word DANGER, WARNING or CAUTION.

⚠ **DANGER**	:	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. (This warning does not apply to this product.)
⚠ **WARNING**	:	Indicates a potentially hazardous situation which, if not avoided, can result in death or serious injury.
⚠ **CAUTION**	:	Indicates a hazardous situation which, if not avoided, will or can result in minor or moderate injury, or serious damage to the product.
⚠	:	The alert symbol shown at left precedes every signal word for hazard warnings, and appears in safety-related descriptions in the manual.
NOTICE	:	Used to present warnings which are not directly related to personal injury hazards, but concern the proper use of the product.

⚠ SAFETY SUMMARY

⚠ General Safety Guidelines (Continued)

- Keep in mind that the hazard warnings in this manual or on the product cannot cover every possible case, as it is impossible to predict and evaluate all circumstances beforehand.
  Be alert and use your common sense.

- When using a chemical for analytical operation, be sure to provide proper ventilation of the laboratory room per local requirements. Inadequate ventilation could endanger human health.

- Do not modify the instrument, replace parts that are not user-serviceable, use non-specified parts, nor remove safety devices, as it could be hazardous.

- Installation at delivery, maintenance and relocation should be referred to service personnel qualified by Hitachi.

- Do not perform any operation or action other than described in this manual. When in doubt, please contact your local Hitachi sales representative or nearest Hitachi service office.

⚠ SAFETY SUMMARY

⚠ WARNING: Ignition of Flammable Chemicals!

Handling of Flammable Chemicals

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - ◇ Leakage of solvent or waste solution
  - ◇ Leakage of solvent inside the instrument
  - ◇ Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING: Explosion of Vapor from Flammable Chemicals!

Handling of Flammable Chemicals

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

⚠ SAFETY SUMMARY

⚠ WARNING: Electric Shock in Contact with Inside of Instrument!

Beware of Electric Shock.
Potentially Dangerous Voltages are Present within the Instrument.

- Before removing the instrument cover for replacement or adjustment of internal parts, be sure to turn OFF the power switch and unplug the power cord.

⚠ WARNING: Electric Shock due to Improper Grounding!

Ground Properly to Prevent Electric Shock Hazard.

- Be sure to use the power cable supplied with the instrument. Use of a different power cable may result in an electric shock hazard.

- This instrument is classified as "1" in IEC1010-1 Annex H and "plug-connected type" in IEC1010-1, so connect the power cable to a grounded 3-wire outlet.

- If a grounded 3-wire outlet is not available, then be sure to provide proper grounding connection.

⚠ SAFETY SUMMARY

NOTICES:

Restriction on Use of Reagents

- Fluorocarbon resin, stainless steel (SUS316), ceramic, ruby and sapphire are used in the flow path of this instrument. Never use reagents that would corrode these materials.

Precautions on Use of Corrosive Solvents

- The drain path for carrying leakage solutions is made of polypropylene.
- The materials inside the instrument are susceptible to corrosion by strong acid, strong alkali and organic solvents.
- When using corrosive solvents, make sure that the tubing connections are not loose.
- Using the pump pressure limiter function or by other means, make setting so that liquid delivery is stopped automatically if leakage occurs.

Precautions on Disposal of Waste Solution

- Be sure to collect waste solution and treat it properly for disposal. Improper disposal treatment of waste solution may result in environmental pollution.

Precaution on Accuracy/Precision of Measured Values

- Use control sample measurements to ensure that the performance of the instrument is normal.

⚠ SAFETY SUMMARY

WARNING LABELS

The warning labels shown below are attached on the Model L-7100 pump.

(1) Ignition of Flammable Chemicals

⚠ WARNING

Beware of Ignition!
Can cause death or serious injury.
Refer to manual when using flammable chemicals.

810-1951

[Attached position]
On right rear side

(2) Explosion of Vapor from Flammable Chemicals

⚠ WARNING

Beware of explosion!
Can cause serious injury.
High concentration of organic solvent vapor may lead to explosion.
Do not allow flammable chemicals to leak.

810-1952

[Attached position]
On right rear side

SAFETY SUMMARY

(3) Electric Shock in Contact with Inside of Instrument

WARNING

Beware of electric shock!
Can cause death or serious injury.
Provide proper grounding connection.
Before removing instrument cover, unplug power cord.

810-1954

[Attached position]

On left rear side

MODEL L-7100 PUMP

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1. CONFIGURATION

The Model L-7100 pump is designed to deliver mobile phases in the liquid chromatograph system.

1-1 Pump Mode

- Pump mode
  - Single-liquid delivery mode
    - Constant flow rate mode
    - Constant pressure mode
  - Low pressure gradient mode
  - High pressure gradient mode

1-1-1 Single-liquid Delivery Mode

The Model L-7100 feeds a single mobile phase in this type of system.

In single-liquid delivery, the constant flow rate mode and the constant pressure mode are available.

Mode	Description
Constant flow rate mode	The mobile phase is delivered at a constant flow rate. Select this mode for analysis using a single solvent.
Constant pressure mode	The mobile phase is delivered at a constant pressure. Select this mode for such a purpose of column packing.

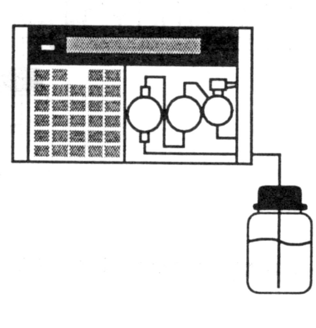

Fig. 1-1 Single-liquid Delivery Mode

1-1-2 Low Pressure Gradient Mode

Mobile phases are joined on the low pressure side of the pump.

We refer to this configuration as a "low pressure gradient mode" since the mobile phases mix before pressurization.
The proportioning valve selects from up to four mobile phases.

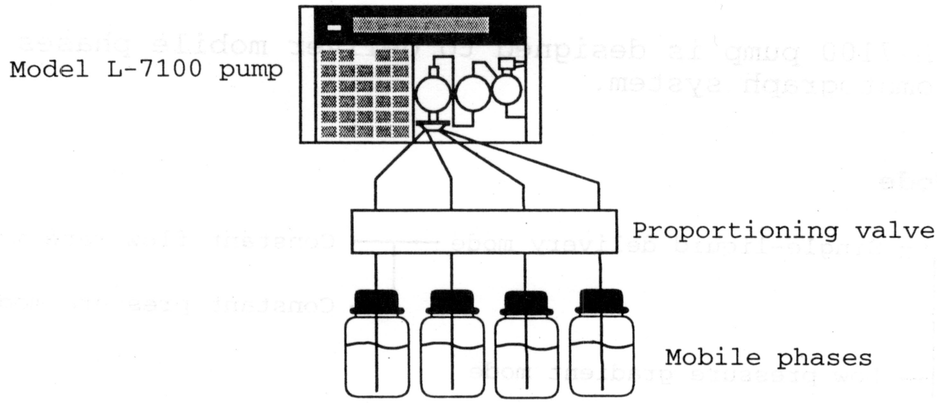

Fig. 1-2 Low Pressure Gradient Mode

1-1-3 High Pressure Gradient Mode

In this configuration, the mobile phases mix after being pressurized by the pump.

Accordingly this mixing method is called a "high pressure gradient mode". This configuration uses two or three pumps for pressurizing each mobile phase independently.

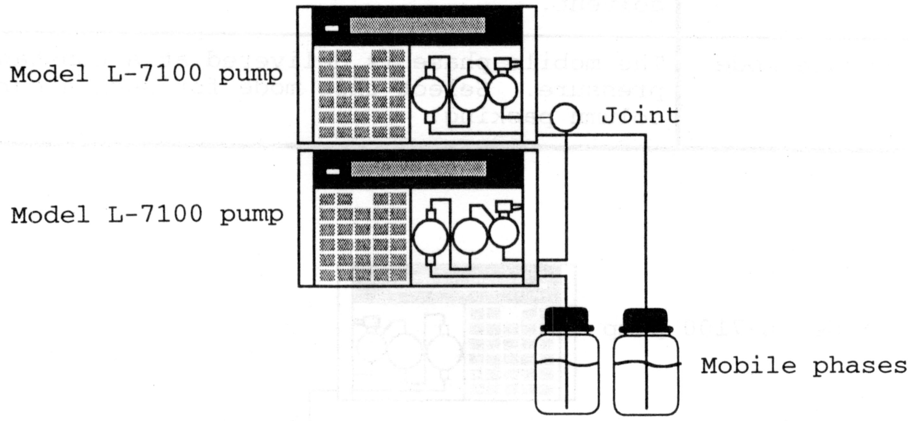

Fig. 1-3 Dual-pump High Pressure Gradient Mode

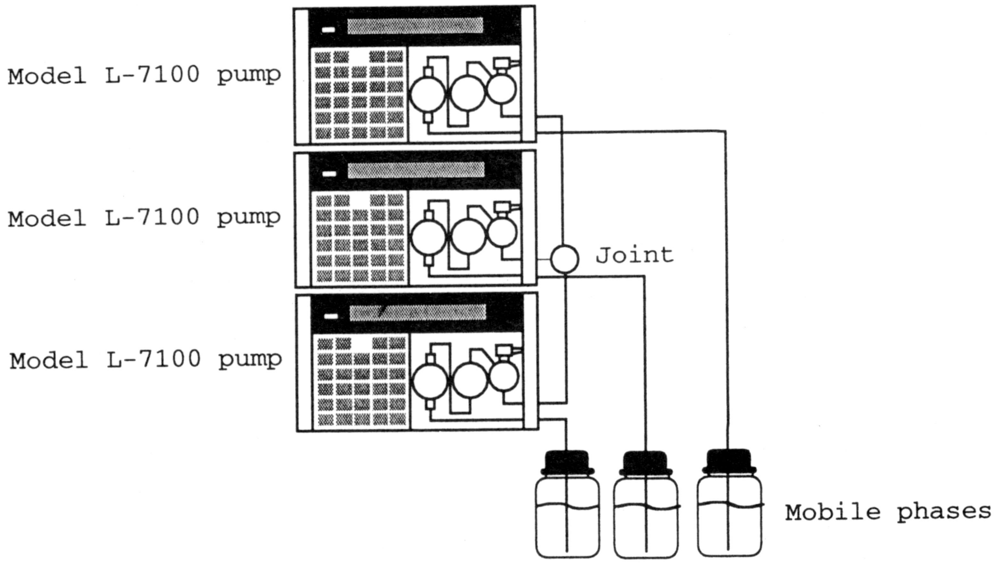

Fig. 1-4 Triple-pump High Pressure Gradient Mode

2. INSTALLATION AND ASSEMBLY

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2. INSTALLATION AND ASSEMBLY

2-1 Installation

NOTICE: Installation of this instrument at delivery shall be carried out by or under supervision of Hitachi's qualified service personnel or its approved service agent.
Prior to installation, please make preparatory arrangements for satisfying the installation requirements referring to this manual.
If relocation of this instrument becomes necessary after its initial installation, please notify your local Hitachi sales representative or nearest Hitachi service office.

2-1-1 Unpacking

Before unpacking, make sure that the bench top can support the weight of the instrument. Carefully unpack the instrument. Gently place it on a bench top.

2-1-2 Checking Contents

After unpacking, check the contents of each box against the packing list that comes with the instrument.
If any part is missing or damaged, contact the nearest Hitachi representative.

2-1-3 Conditions for the Installation

Confirm the following requirements before installing the instrument.

(1) Power Supply

Line voltage	:	100 to 240 V AC Fluctuation should be within ±10% of the rated voltage.
Frequency	:	50 or 60 Hz Fluctuation should be within ±0.5 Hz of the rated frequency.
Power capacity	:	100 VA or more This is for Model L-7100 pump only. Make sure that there is an adequate margin since power may be shared with accessory units.

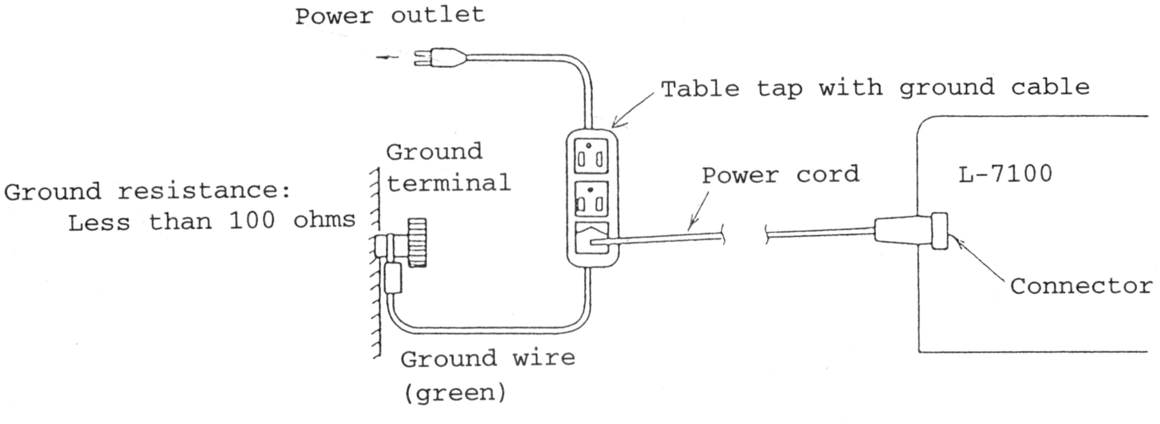
(2) Ground Terminal

⚠ WARNING

Ground Properly to Prevent Electric Shock Hazard!

- Be sure to use the power cable supplied with the instrument. Use of a different power cable may result in an electric shock hazard.
- This instrument is classified as "1" in IEC1010-1 Annex H and "plug-connected type" in IEC1010-1, so connect the power cable to a grounded 3-wire outlet.
- If a grounded 3-wire outlet is not available, then be sure to provide proper grounding connection.

It is required to provide grounding connection having resistance of less than 100 ohms within a distance of three meters.



2-1-4 Place of Installation

The place for installation should meet the following requirements.
A minimum bench width of 450 mm and depth of 700 mm.
A minimum open space of 100 mm should exist behind the instrument.
A surface should be capable of withstanding a load of 50 kg or more.

> **NOTICE:** For the liquid chromatograph system, prepare a bench or desk that is more than 1300 mm wide, more than 700 mm deep, and is capable of bearing a weight of 170 kg. For installing optional units, prepare a bench capable of bearing a weight including their additional weights.

2-1-5 Installation Environment

The following environmental conditions should exist.

(1) Operating Temperature

The temperature should be within a range of 4 to 35 degrees Centigrade and free from significant variations during measurement.
Temperature conditions should not lead to condensation.

(2) Operating Humidity

The humidity range should be between 45 to 85%.

(3) Atmospheric Gas

(a) It should have adequate ventilation.

(b) It should be free from acidic, alkaline or any gas that may corrode metal.

(c) It should be free from organic solvent gases (in particular, benzine and paint thinner) which may dissolve the instrument painted surfaces.

(4) Other

(a) Do not place the instrument near a window that will expose it to direct sunlight. If exposed to direct sunlight, performance may degrade due to temperature fluctuations. Direct sunlight may discolor the instrument painted surfaces.

(b) Protect the unit against drafts. Drafts make temperature unstable and may affect performance.

(c) Do not expose the instrument to any strong vibration or shock.

(d) Do not place the instrument near equipment that radiates heat. Do not place it near gas burners, electric heaters, or ovens.

(e) Do not place your instrument near equipment that generates intense magnetic fields such as electric welding equipment, high frequency furnaces, pole transformers, etc.

(f) Protect the instrument from excessive dust. Dust may contaminate solvents or plug filters.

(g) Connect your instrument to lines that are free from sudden changes or voltage fluctuations. Voltage fluctuations will increase detector noise.

(h) If you must use power motor-driven equipment (such as a stirrer or vibrator) in the same line as your instrument, ensure that a noise reduction device is in the same power line.

NOTICE: The control section of this instrument comprises the LSI microcomputer circuit. To prevent a possible trouble, be sure to observe the above instructions.

2-1-6 Required Items for the Performance Check

Ensure that the items listed in Table 2-1 are available to check the instrument performance.

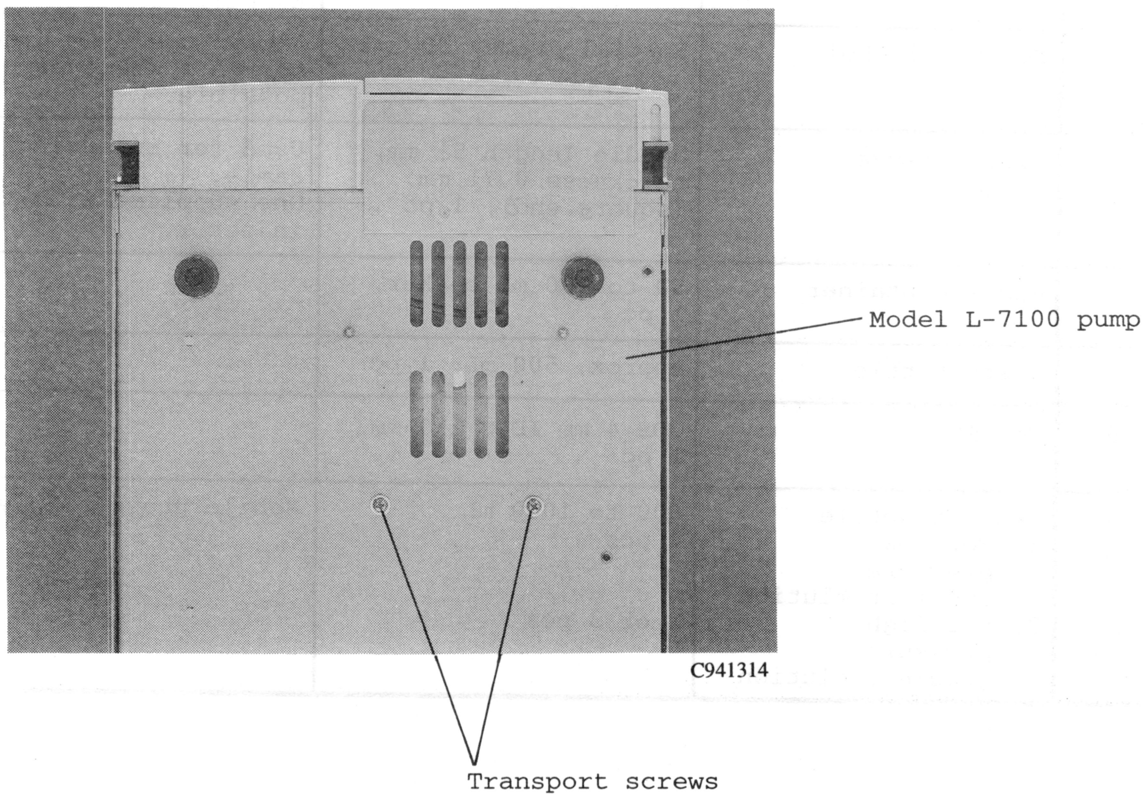
Table 2-1 Items Required and Supplied by the User

No.	Item	Description	Remarks
1	Distilled water	500 mL	1000 mL required for low pressure gradient elution.
2	Methyl alcohol	Special grade, 500 mL	Always use HPLC grade solvents whenever possible.
3	Microsyringe	Needle length 51 mm, thickness 0.71 mm, (square end), 1 pc	Used for injecting samle. One supplied with injector.
4	Waste container	50 to 100 mL beaker, 1 pc	
5	Waste bottle	Approx. 500 mL, 1 pc	
6	Column	ODS 4 mm ID × 150 mm, 1 pc	
7	Reagent bottle 1) For low pressure gradient elution 2) For high pressure gradient elution	500 to 1000 mL 4 pcs 2 or 3 pcs	Mobile phase supply.

NOTICE: Removal of the Transport Screws

1. There are two screws that secure the pump for transport. Remove them before operation. These screws are at the bottom face of the pump.

2. Use a Phillips screwdriver to remove the transport screws.



2-2 Assembly

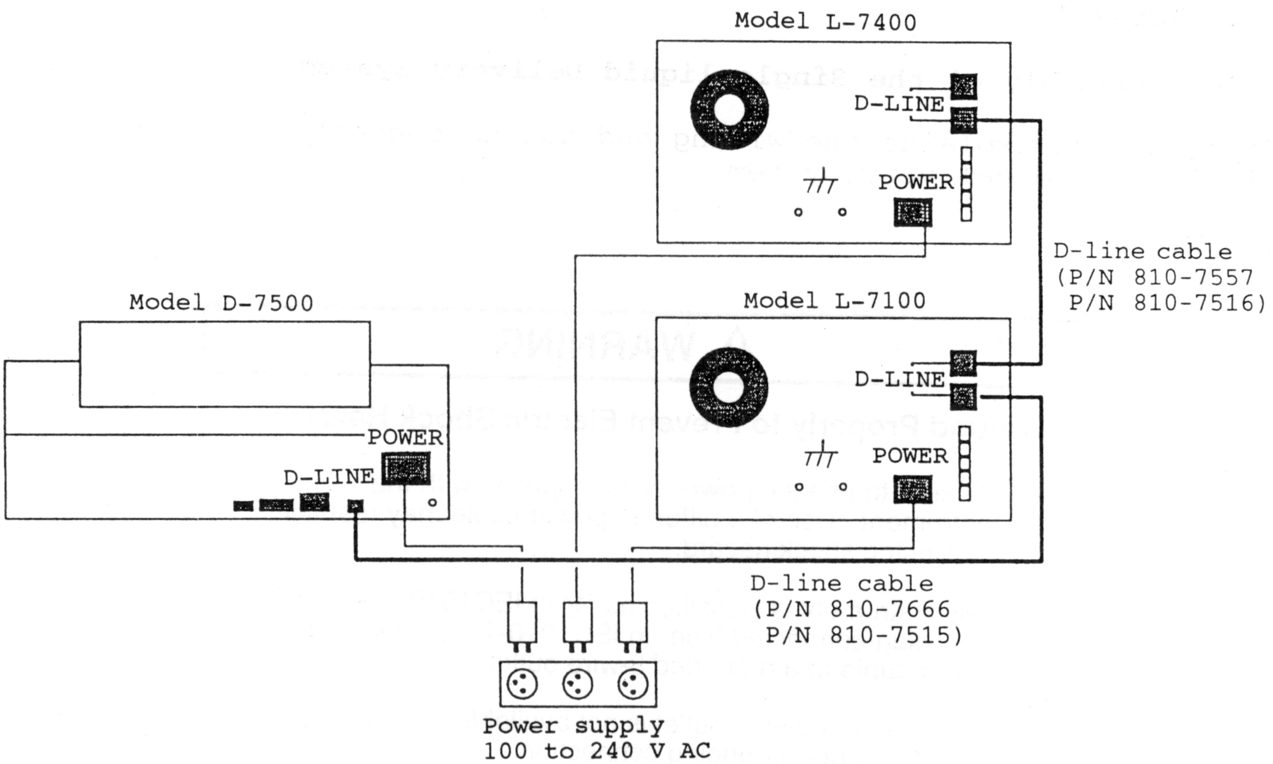
2-2-1 Assembly of the Single-liquid Delivery System

This section explains the wiring and tubing connections of a single-liquid delivery system.

(1) Wiring

> **⚠ WARNING**
>
> **Ground Properly to Prevent Electric Shock Hazard!**
>
> - Be sure to use the power cable supplied with the instrument. Use of a different power cable may result in an electric shock hazard.
> - This instrument is classified as "1" in IEC1010-1 Annex H and "plug-connected type" in IEC1010-1, so connect the power cable to a grounded 3-wire outlet.
> - If a grounded 3-wire outlet is not available, then be sure to provide proper grounding connection.

When connecting each unit via D-line cable, connect one end of the D-line cable to the D-line connector indicated "RELAY BOX" on the unit and the other end of the cable to the D-line connector not indicated "RELAY BOX".



NOTICE:	The part number indicated on the second line represents the D-line cable designed for the instrument bearing the CE conformity marking.

Fig. 2-1 Wiring of Single-liquid Delivery System

NOTICE 1:	Before connecting the power cord, ensure that the POWER switch of each unit is turned off.
NOTICE 2:	The power cord should connect to a power outlet which provides the rated voltage ±10%, has a capacity of 5 A or more, and is free from considerable voltage fluctuation.

(2) Tubing Connections

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

Before making tubing connections, place the devices as shown in Fig. 2-2. Then connect the tubing as shown in Fig. 2-3, and as described in the next that follows.

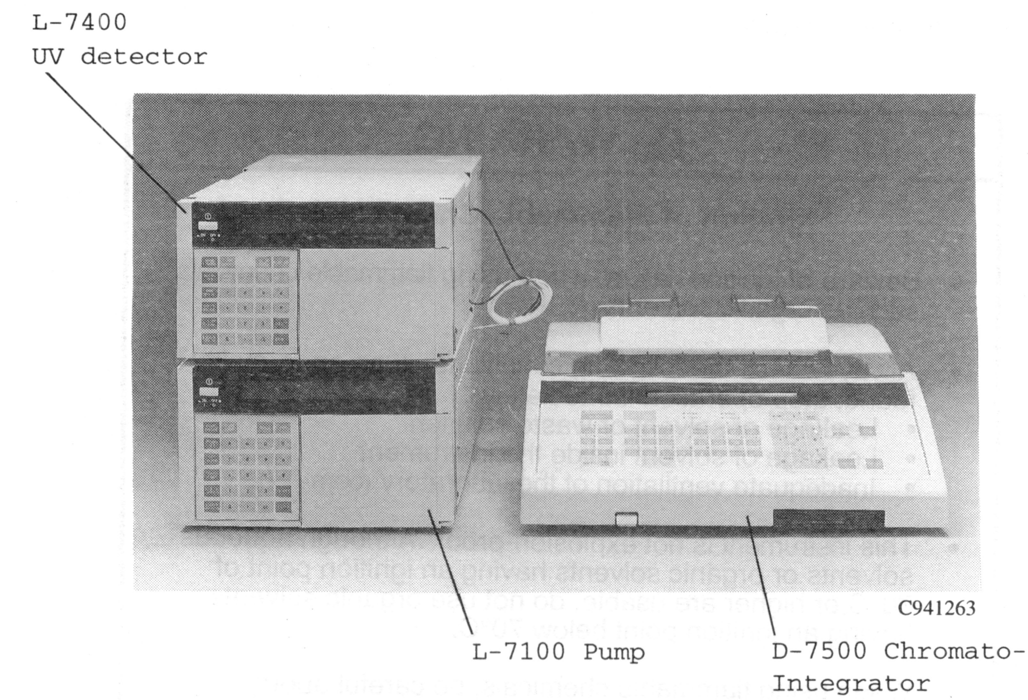
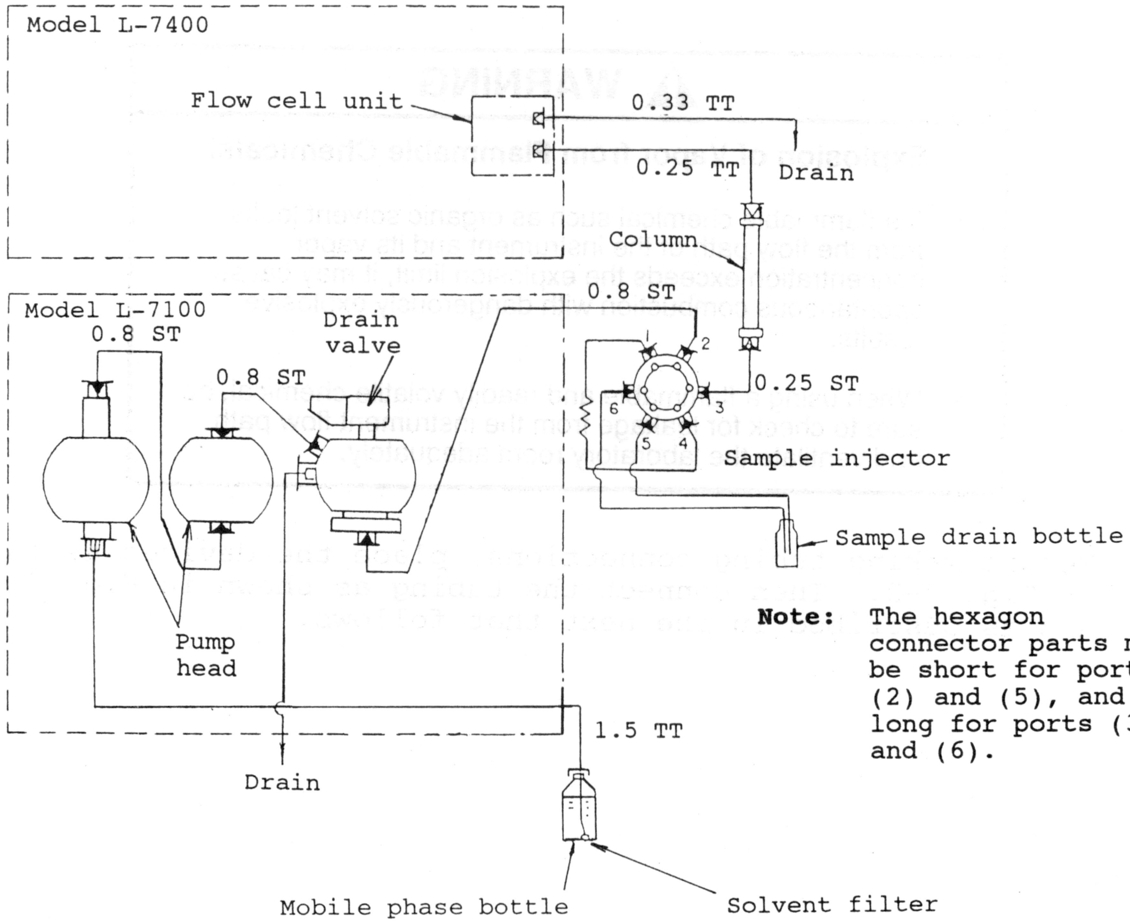


Fig. 2-2 Typical Arrangement

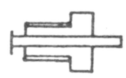
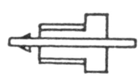
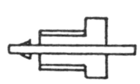
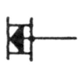
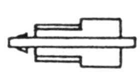


Note: The hexagon connector parts must be short for ports (2) and (5), and long for ports (3) and (6).

Fig. 2-3 Tubing Diagram

Table 2-3 is the key for the connectors given in the diagram of Fig. 2-3. It provides an explanation of the symbols and gives a description of its usage.

Table 2-3 Tubing Connection Symbols and Description

Symbol	Sketch	Applied Tube and Pipe
		· For connection of INLET tube and Drain tube · 1.0 TT (PTFE tube, inner diameter 1.0 mm, outer diameter 2.0 mm) · 1.5 TT (PTFE tube, inner diameter 1.5 mm, outer diameter 3.0 mm)
		· For connection of tube, outer diameter 1.57 mm · 0.25 TT (PTFE tube, inner diameter 0.25 mm, outer diameter 1.57 mm) · 0.33 TT (PTFE tube, inner diameter 0.33 mm, outer diameter 1.57 mm) · 0.5 TT (PTFE tube, inner diameter 0.5 mm, outer diameter 1.57 mm)
		· For connection of SUS pipe, outer diameter 1.57 mm · 0.25 ST (SUS 316 pipe, inner diameter 0.25 mm, outer diameter 1.57 mm) · 0.8 ST (SUS 316 pipe, inner diameter 0.8 mm, outer diameter 1.57 mm)
		· Push screw for tubing of Rheodyne injector (Push screw dimensions are in inches)

2-2-2 Assembly of the Low Pressure Gradient System

Wiring and tubing connections of a low pressure gradient system are as follows.

(1) Wiring

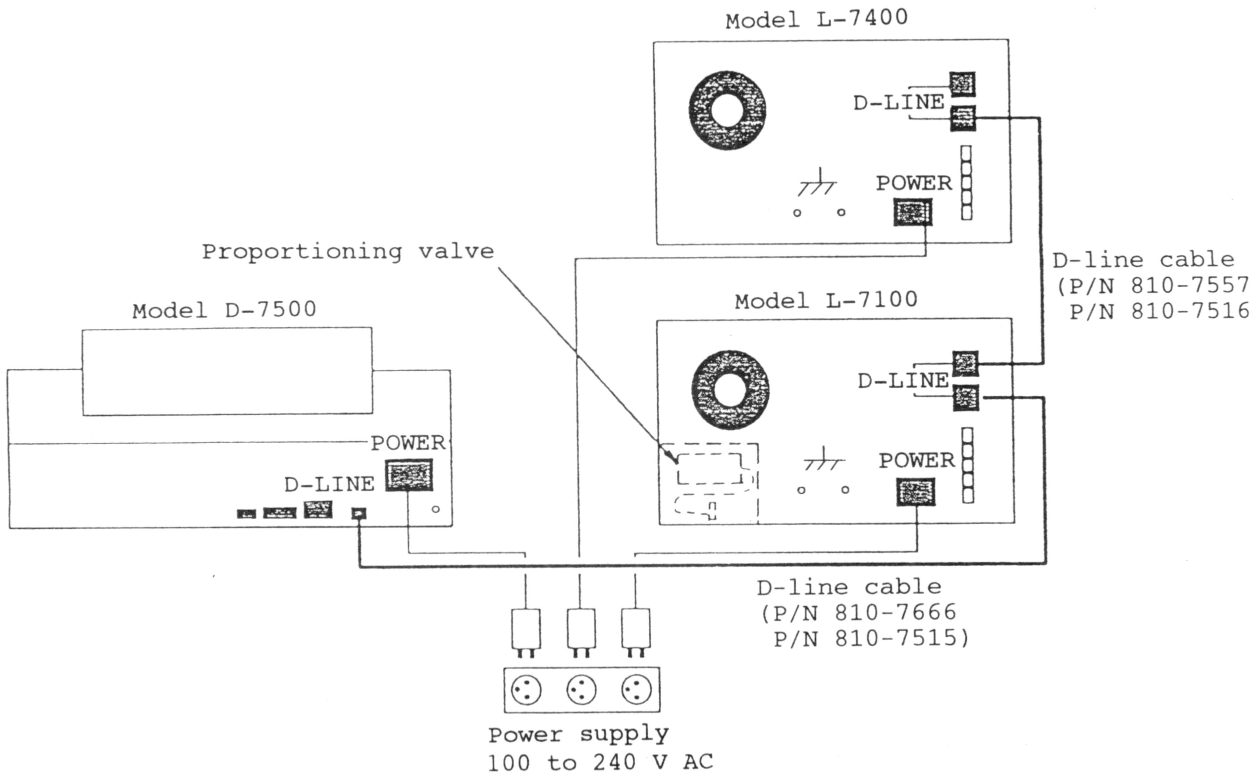
⚠ WARNING

Ground Properly to Prevent Electric Shock Hazard!

- Be sure to use the power cable supplied with the instrument. Use of a different power cable may result in an electric shock hazard.
- This instrument is classified as "1" in IEC1010-1 Annex H and "plug-connected type" in IEC1010-1, so connect the power cable to a grounded 3-wire outlet.
- If a grounded 3-wire outlet is not available, then be sure to provide proper grounding connection.

A low pressure gradient system should be wired as shown below.

When connecting each unit via D-line cable, connect one end of the D-line cable to the D-line connector indicated "RELAY BOX" on the unit and the other end of the cable to the D-line connector not indicated "RELAY BOX".



NOTICE: The part number indicated on the second line represents the D-line cable designed for the instrument bearing the CE conformity marking.

Fig. 2-4 Wiring of Low Pressure Gradient System

NOTICE 1: Before connecting the power cord, ensure that the POWER switch of each unit is turned off.

NOTICE 2: The power cord should connect to a power outlet which provides 10% of the rated voltage, has a capacity of 5 A or more, and is free from considerable voltage fluctuation.

(2) Tubing Connections

(a) Mounting of Proportioning Valve

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

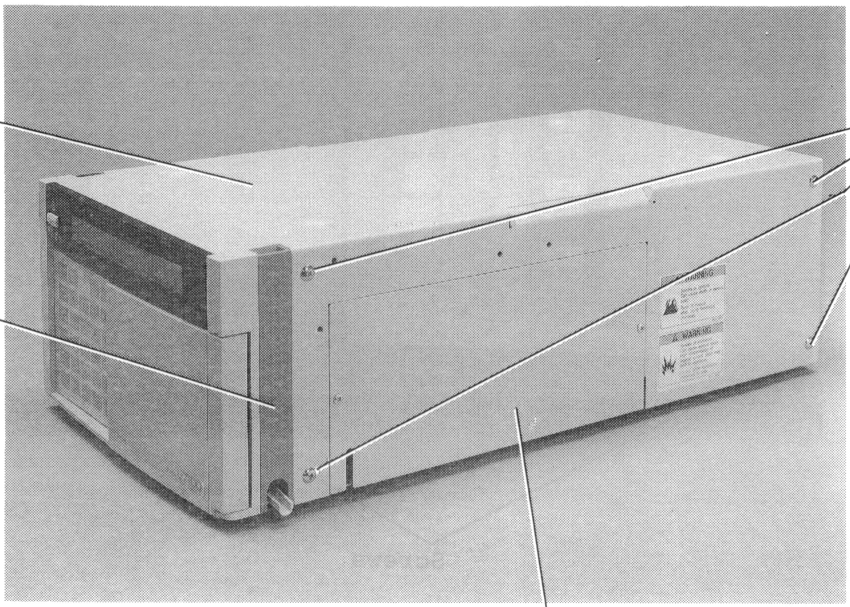
⚠ WARNING

Beware of Electric Shock!

Potentially Dangerous Voltages are Present within the Instrument.

Before removing the instrument cover for replacement or adjustment of inside parts, be sure to turn OFF the power switch and unplug the power cord.

1) Loosen the four set screws on the pump cover, and detach it. Remove the duct cover that is on the right side.



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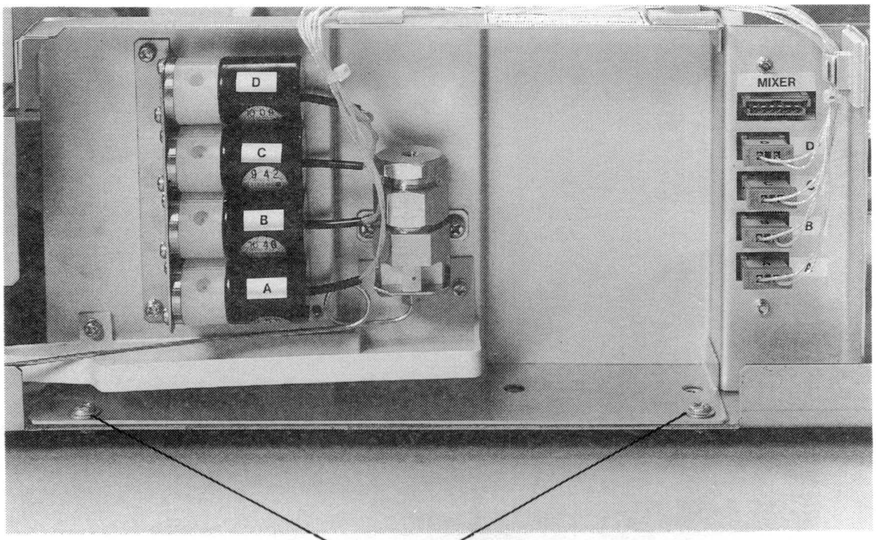
2) Connect wiring between pump and proportioning valve.

C942982

3) Mount the proportioning valve on the pump unit. Secure it with the two retaining screws.



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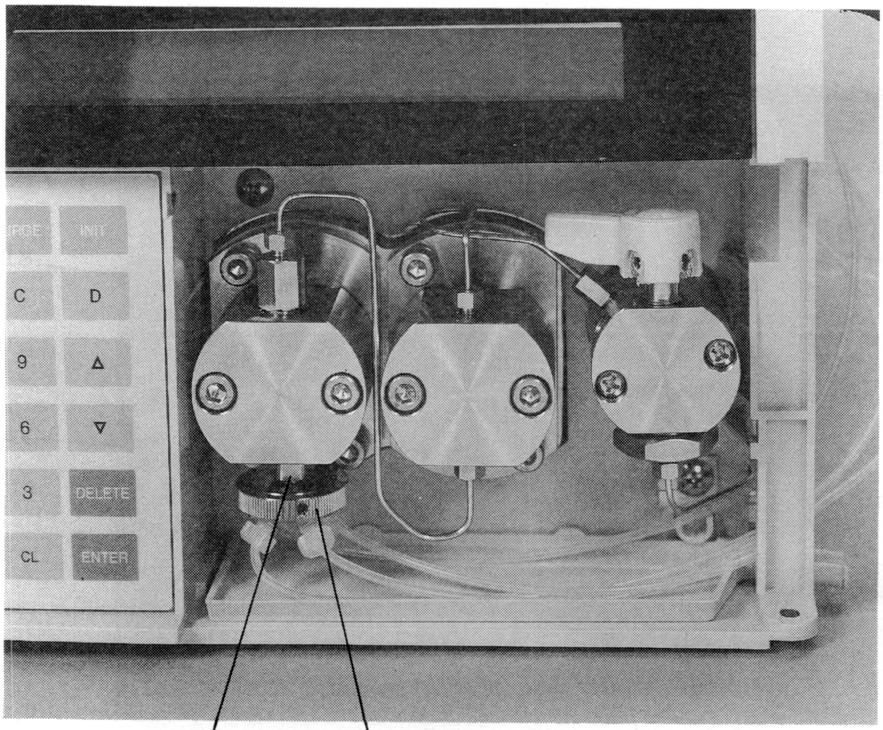
Screws

4) Take the four-way joint of tubing that extends from the solenoid valve and insert it into the IN position of the pump head.

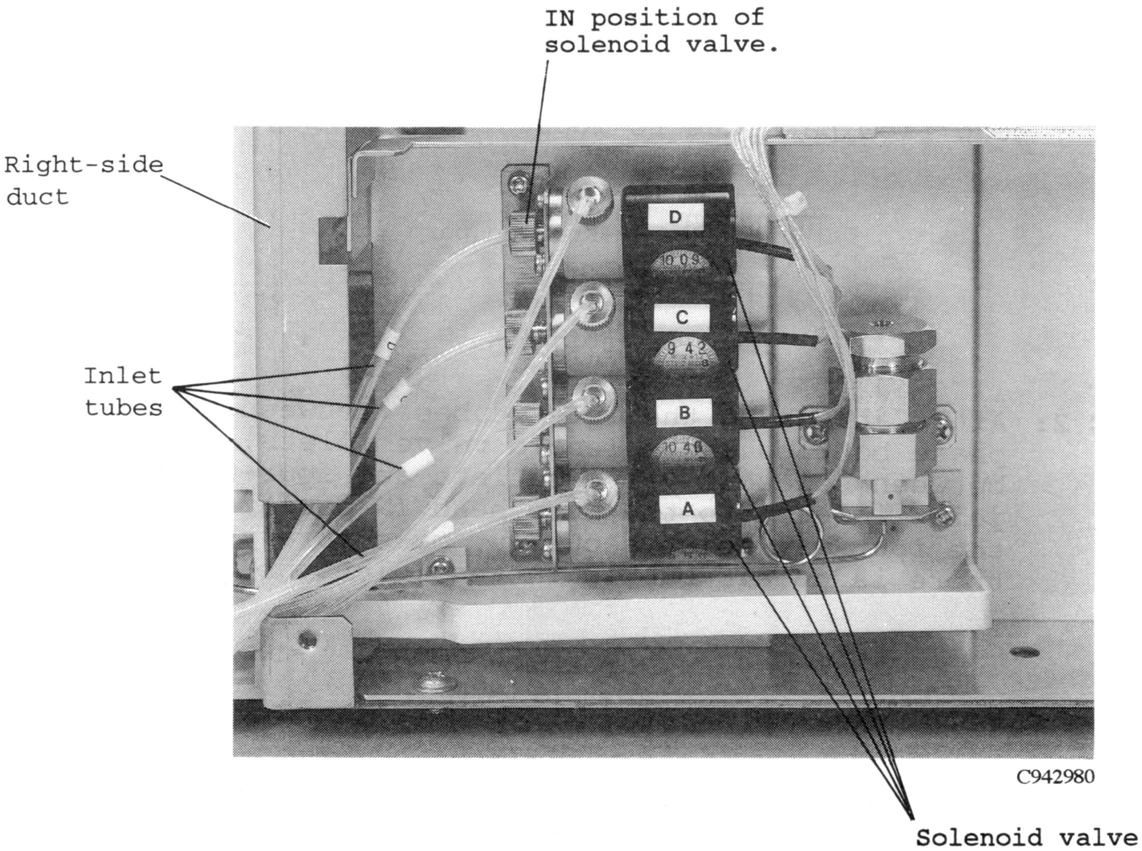


C942984

In position of the pump head

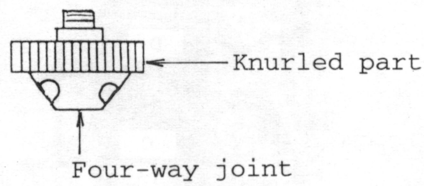
Four-way joint

5) Connect the inlet tubes to the IN position of each solenoid valve. Run each inlet tube through the right-side duct, and re-attach the duct cover.

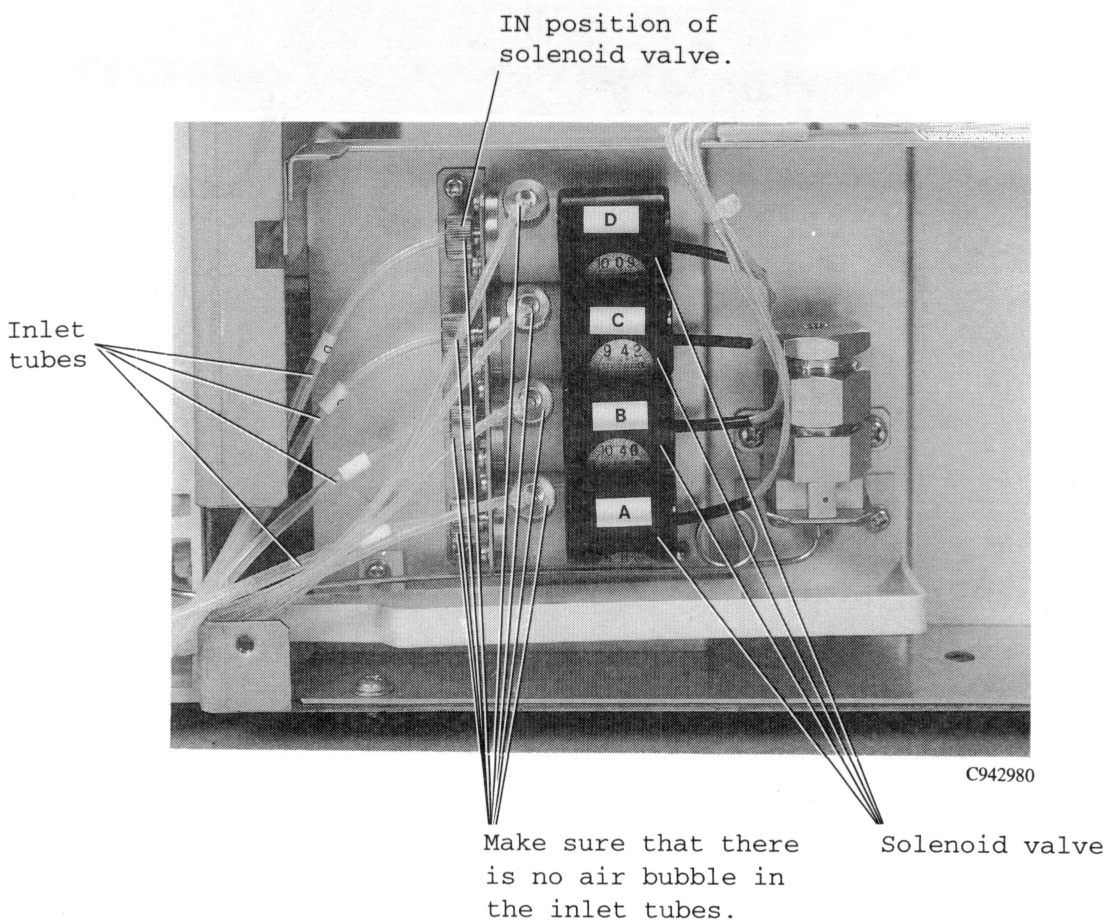


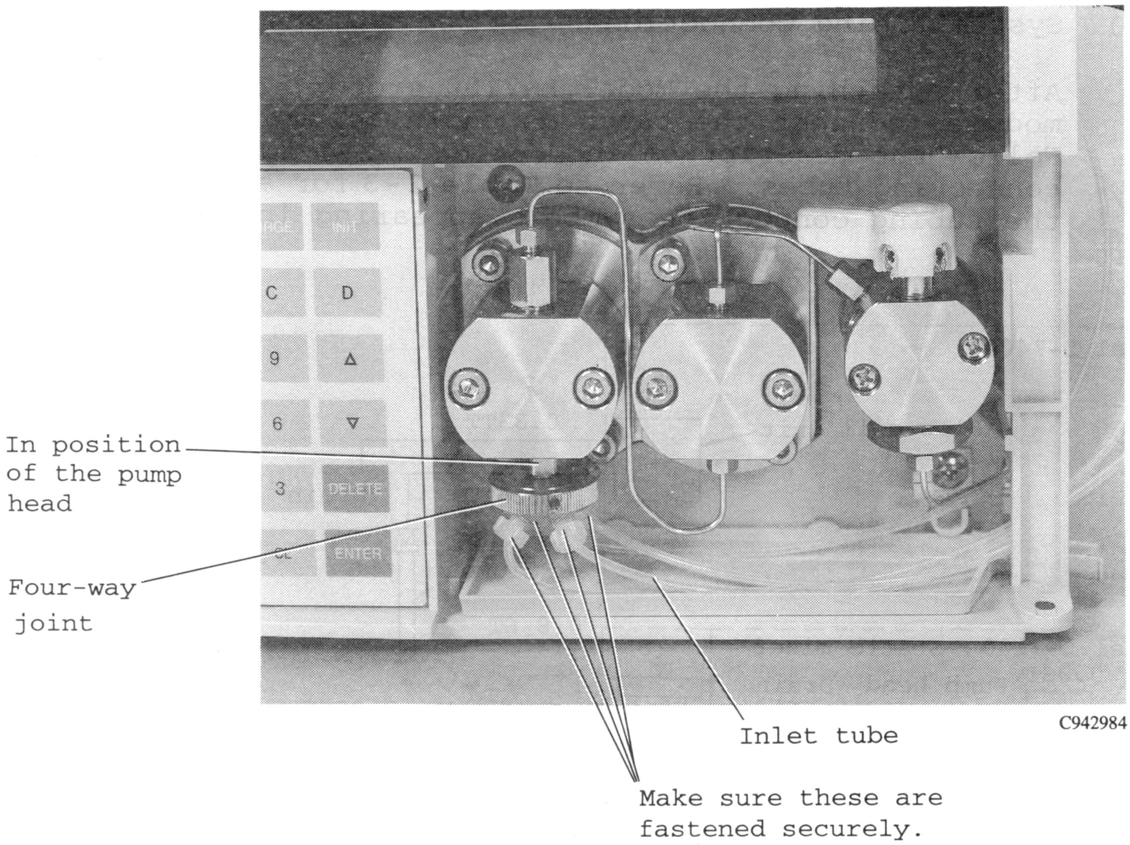
6) Return the pump cover to its place, and secure it with four screws.

NOTICE 1: Before attaching the four-way joint to the IN position of pump, check that the knurled part of four-way joint rotates smoothly. If not smooth, then the joint may not be attachable completely to the IN position and/or air bubbles may enter the flow path due to looseness of the joint.

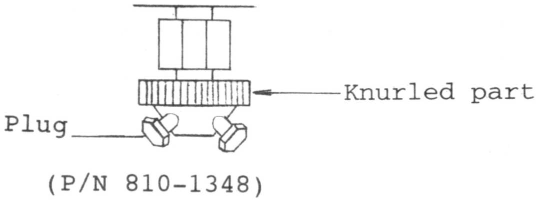


NOTICE 2: After attaching the inlet tubes (between mobile phase bottles and solenoid valve inlets, and between solenoid valve outlets and four-way joint inlets) to the pump head IN position of the four-way joint securely, make sure that there is no air bubble in the inlet tubes.





NOTICE 3: When only mobile phases A and B are used, disconnect the C and D flow path tubes and place the plug in each opening. And when only mobile phases A, B and C are used, disconnect the D flow path tube and place the plug in the opening.



NOTICE 4: On an unused mobile phase bottle, be sure to close the lid.

(b) System Piping Connections

After attaching the Model L-7100 proportioning valve module, connect the tubes as shown below.
Follow the description in section 2-2-4 for the method of connecting tubes. Refer to **Table 2-3** for a description of the tubing connection symbols appearing in the figure.

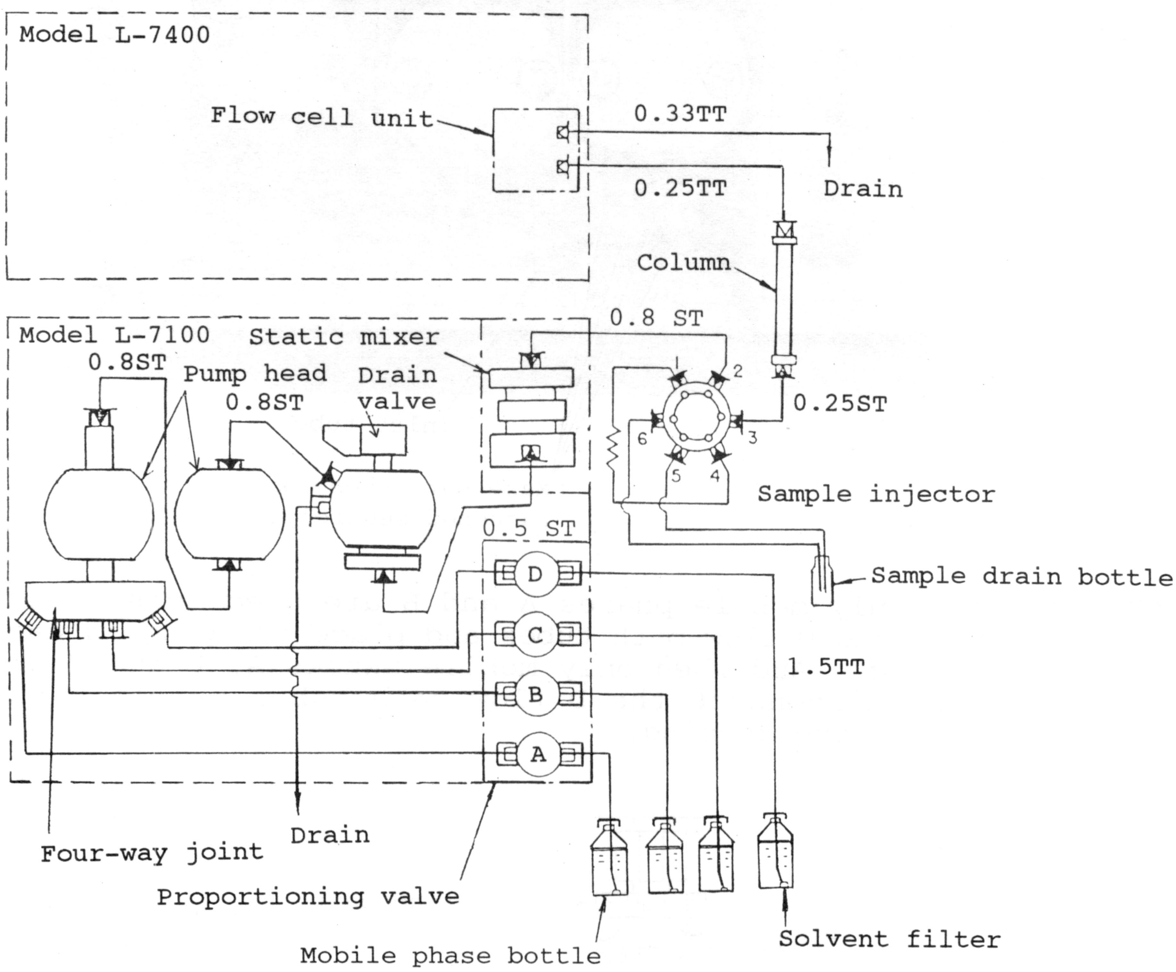
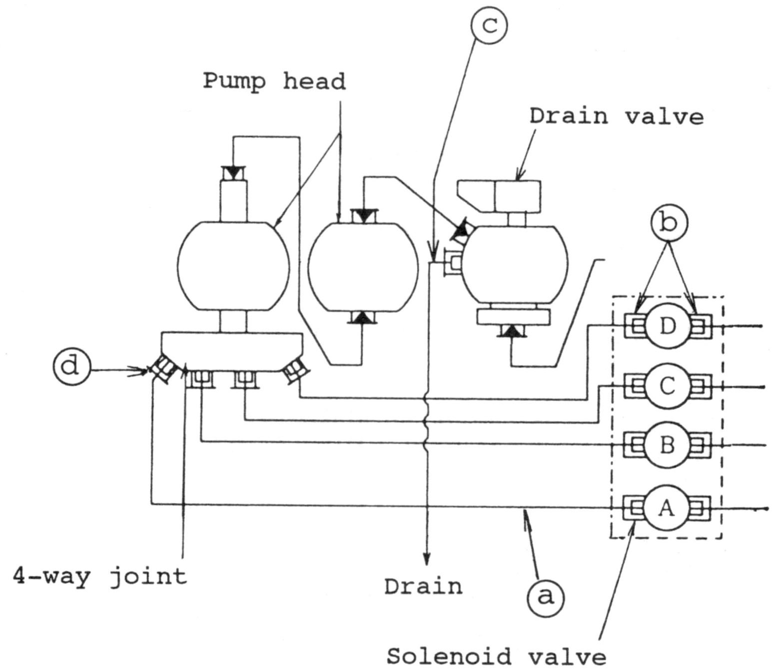


Fig. 2-5 Tubing of Low Pressure Gradient System

If air bubbles are contained in the piping between mobile phase bottle and detector outlet in the low-pressure gradient system, its full performance cannot be attained. So, before using the low-pressure gradient system, make sure that no air is introduced through the piping joints. For this check, take the following procedure.

(i) Connect the pipes, and feed each mobile phase so that the pipes will be filled with mobile phase.



(ii) Check for air bubbles

1. With each pipe being filled with mobile phase, open the drain valve and perform pursing with liquid A (at a flow rate of 9.999 mL/min). At this step, check that there is no air bubble at part a .

2. In the same manner, perform purging with liquid B (at a flow rate of 9.999 mL/min), and check that there is no air bubble at part a .

3. If air bubbles remain even after the above steps 1 and 2 are repeated a few times, retighten the setscrew of the solenoid valve at part b . Secure it positively with hand.

4. Further, while performing purging (at a flow rate of 9.999 mL/min), check that no air bubble appears at part c . If air bubbles are found at part c , retighten the setscrew of part d and the plug.

5. Check that no air is introduced even in liquid feed (purging) at a flow rate of 9.999 mL/min.

(iii) Stabilization

Make sure that no air is introduced.

2-2-3 Assembly of the High Pressure Gradient System

In this system, the high pressure gradient unit is installed at the right side of the pump. The instructions on piping and wiring for the system are explained below.

(1) Wiring

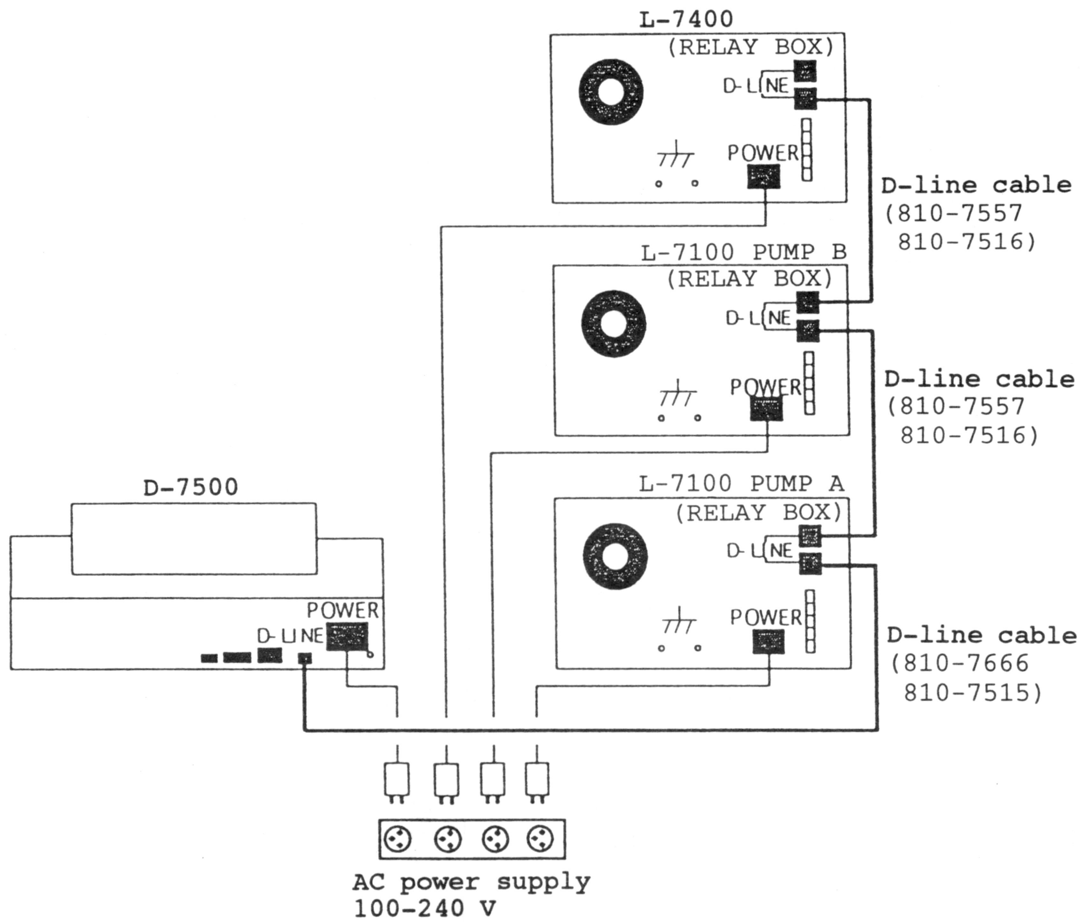
⚠ WARNING

Ground Properly to Prevent Electric Shock Hazard!

- Be sure to use the power cable supplied with the instrument. Use of a different power cable may result in an electric shock hazard.
- This instrument is classified as "1" in IEC1010-1 Annex H and "plug-connected type" in IEC1010-1, so connect the power cable to a grounded 3-wire outlet.
- If a grounded 3-wire outlet is not available, then be sure to provide proper grounding connection.

Figure 2-6 describes the wiring for the two-liquid high pressure gradient system.
Use a D-line cable for connection between pumps. Connect one end of the D-line cable to the D-line connector indicated "RELAY BOX" on pump A and the other end of the cable to the D-line connector not indicated "RELAY BOX" on pump B. When using D-line cable for connecting other modules as well, connect one end of the D-line cable to the D-line connector indicated "RELAY BOX" on the module and the other end of the cable to the D-line connector not indicated "RELAY BOX".

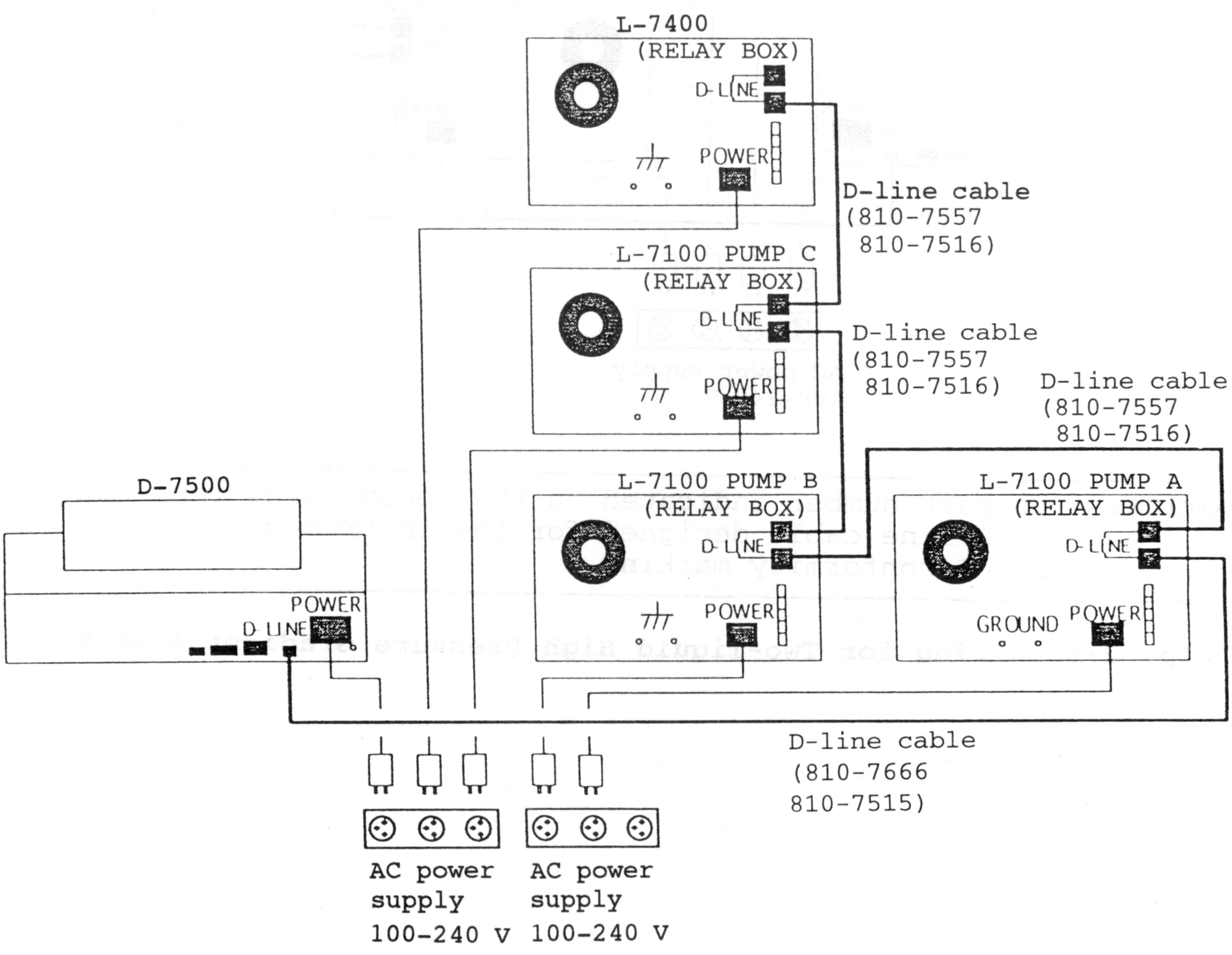
NOTICE: If wiring connections are not made as instructed above, the high pressure gradient operation cannot be performed.



NOTICE:	The part number indicated on the second line represents the D-line cable designed for the instrument bearing the CE conformity marking.

Fig. 2-6 Wiring for Two-liquid High Pressure Gradient System

Figure 2-7 describes the wiring for the three-liquid system. Use a D-line cable for connection between pumps. Connect one end of the D-line cable to the D-line connector indicated "RELAY BOX" on pump A and the other end of the cable to the D-line connector not indicated "RELAY BOX" on pump B. Also, connect one end of the D-line cable to the D-line connector indicated "RELAY BOX" on pump B and the other end of the cable to the D-line connector not indicated "RELAY BOX" on pump C. When using D-line cable for connecting other modules as well, connect one end of the D-line cable to the D-line connector indicated "RELAY BOX" on the module and the other end of the cable to the D-line connector not indicated "RELAY BOX".



NOTICE:	The part number indicated on the second line represents the D-line cable designed for the instrument bearing the CE conformity marking.

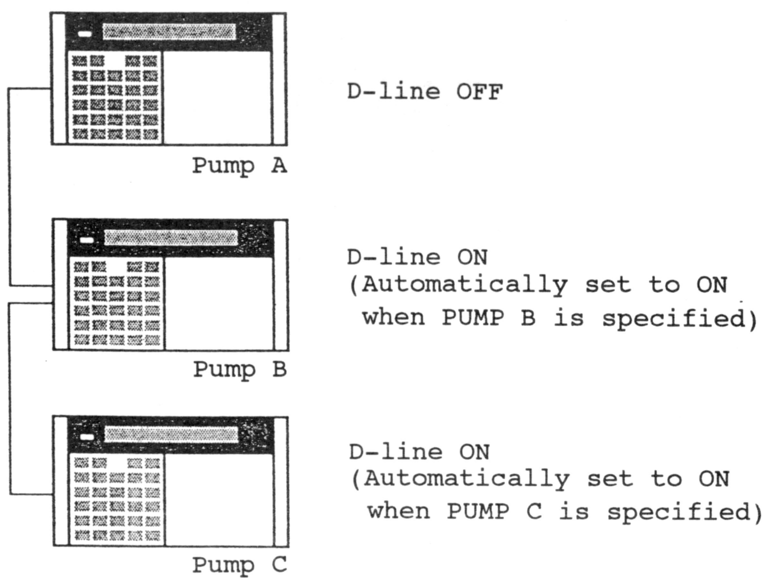
Fig. 2-7 Wiring for Three-liquid High Pressure Gradient System

(2) Notes on High Pressure Gradient System

(a) The high pressure gradient system can be set up using the D-line cables only. In this case, be sure to provide direct connections among the pumps using the D-line cables. If indirect connection is made via other module, it becomes impossible to control the high pressure gradient system.

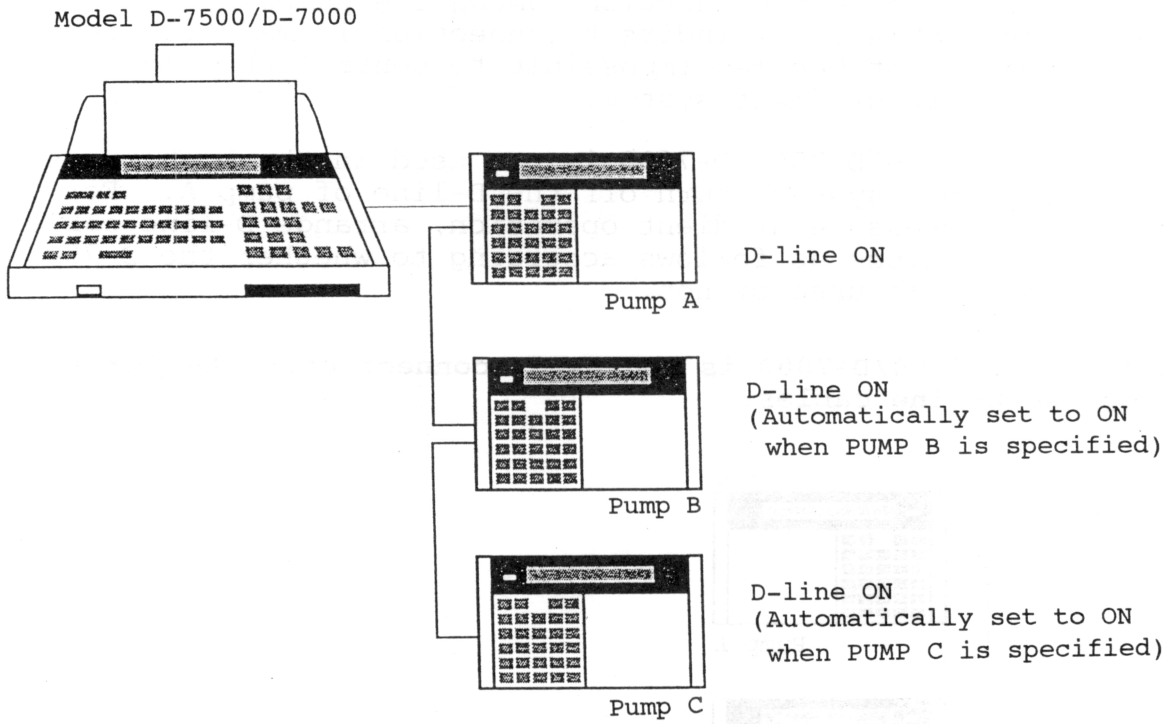
(b) Where the D-7500/D-7000 is not used in the high pressure gradient system, turn off the D-line of pump A. For high pressure gradient operation, arrange D-line cable connections as follows according to whether the D-7500/ D-7000 is used or not.

- **Where the D-7500/D-7000 is not used, connect only the pumps using the D-line cables.**



NOTICE:	If the D-line of pump A is set to ON by mistake, the message "D-LINE SYSTEM IS NOT READY" appears on the LCD screen (remains on it). Under this condition, the high pressure gradient system is not usable.

• **Where the D-7500/D-7000 is used, connect pump A with the D-7500/D-7000 using the D-line cable.**



(3) Piping

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

⚠ WARNING

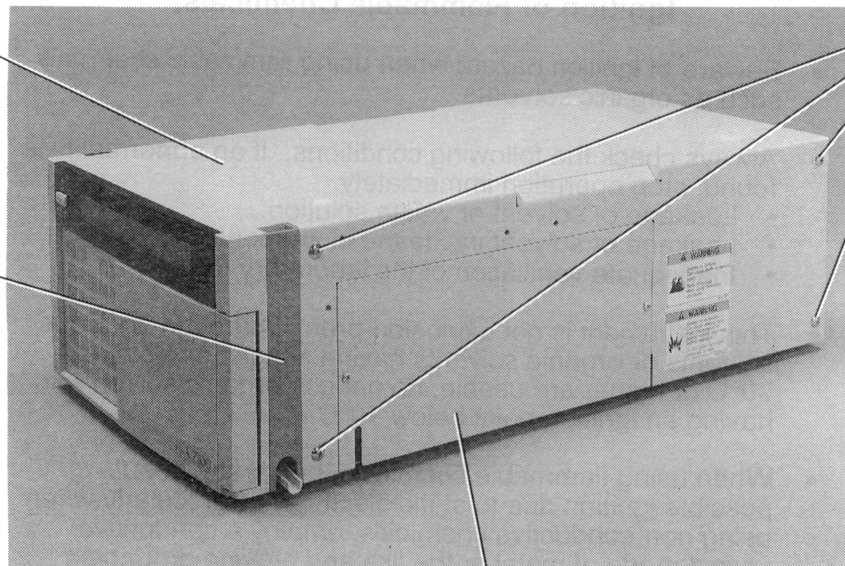
Beware of Electric Shock!

Potentially Dangerous Voltages are Present within the Instrument.

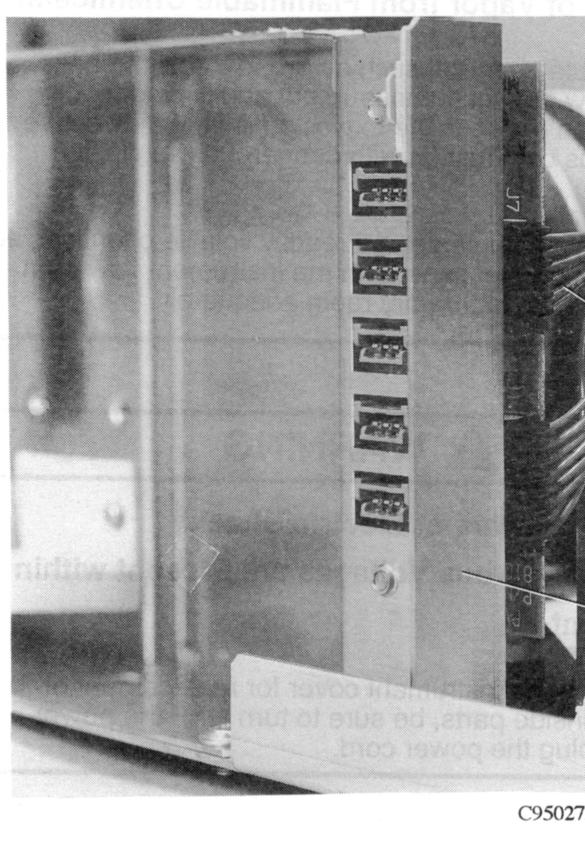
Before removing the instrument cover for replacement or adjustment of inside parts, be sure to turn OFF the power switch and unplug the power cord.

Install the high pressure gradient components at the right side of the pump in the procedure described below.

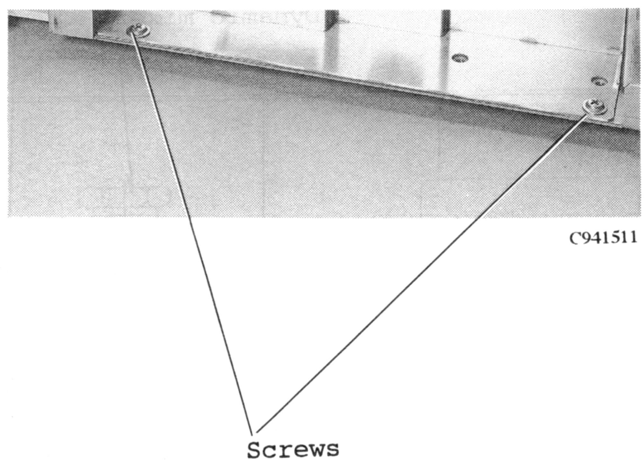
(a) Remove the screws from the pump cover and detach the cover. Also detach the right-side duct cover.



(b) Connect the wiring between the pump and gradient system casing.



(c) Fasten the gradient system casing to the pump by means of two screws.



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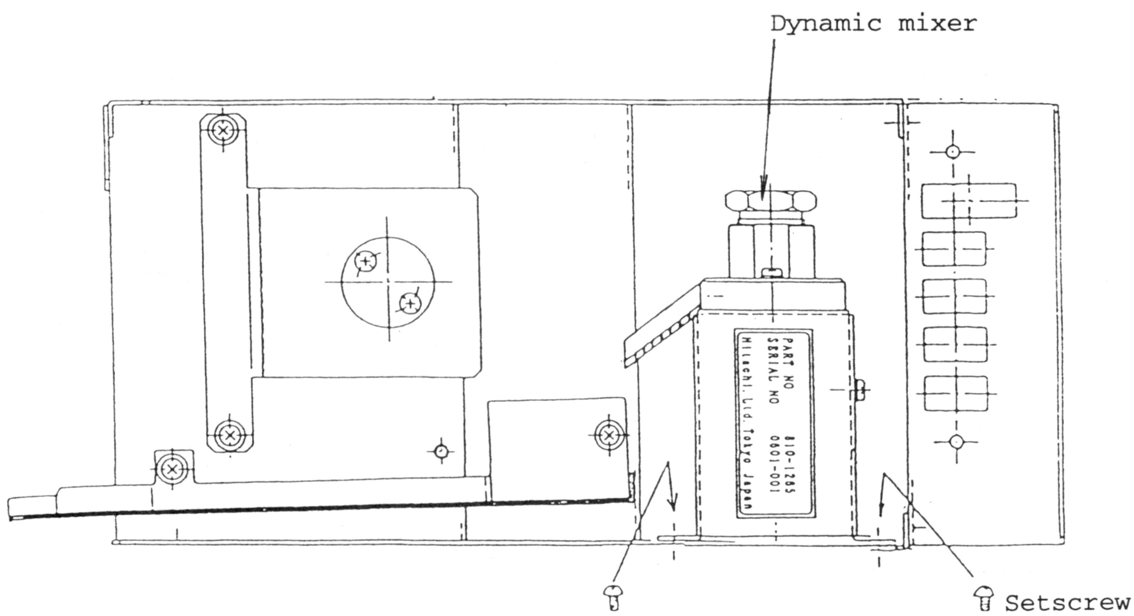
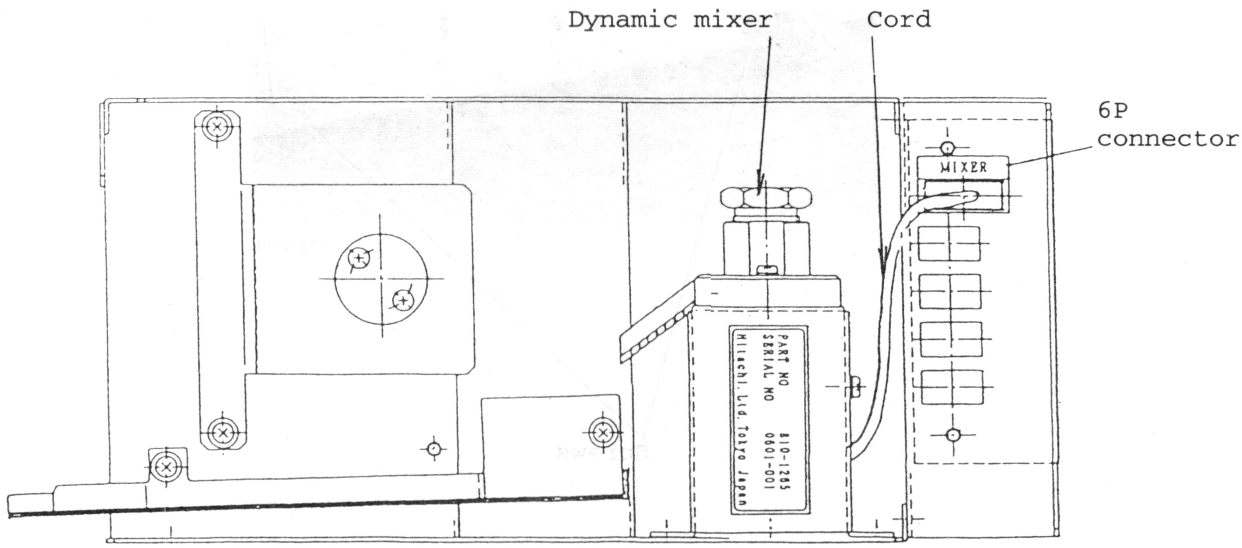
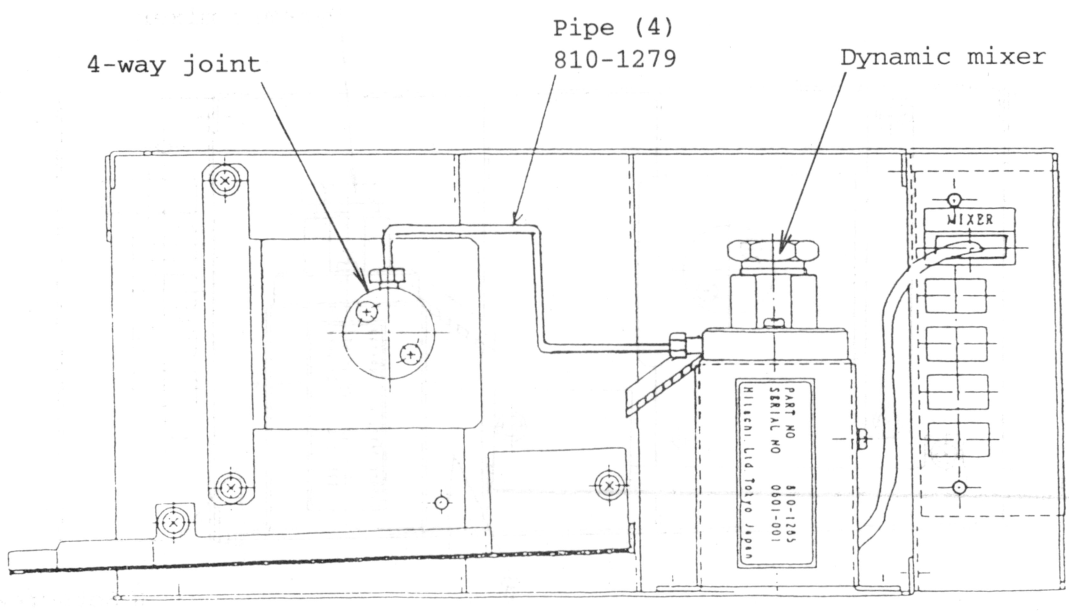
(d) Fasten the dynamic mixer to the gradient system casing by means of two screws.



(e) Attach the connector of dynamic mixer to the 6P connector of gradient system casing through the MIX SO circuit board (810-7004).

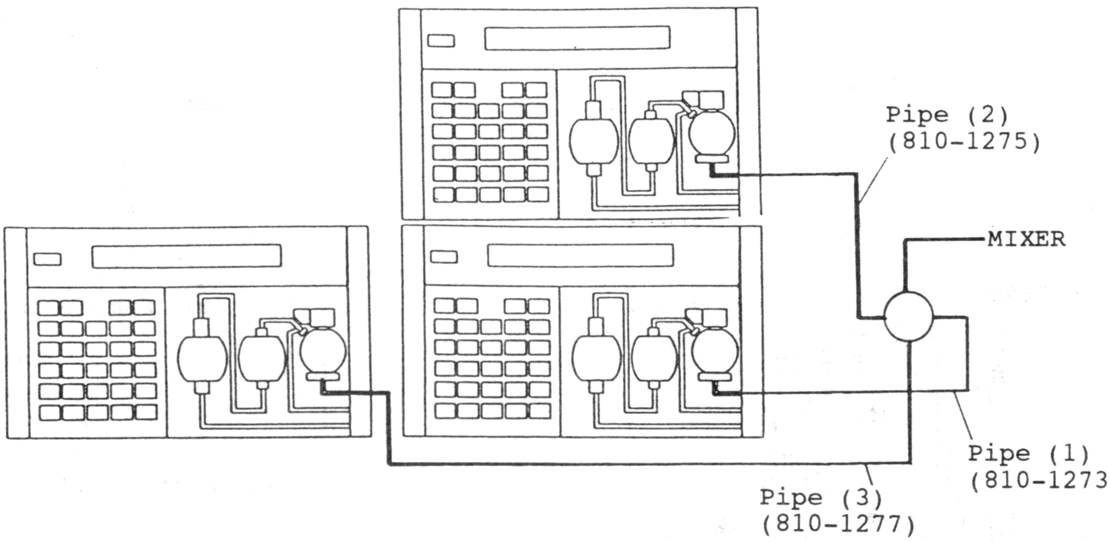


(f) Connect piping between the 4-way joint and dynamic mixer.



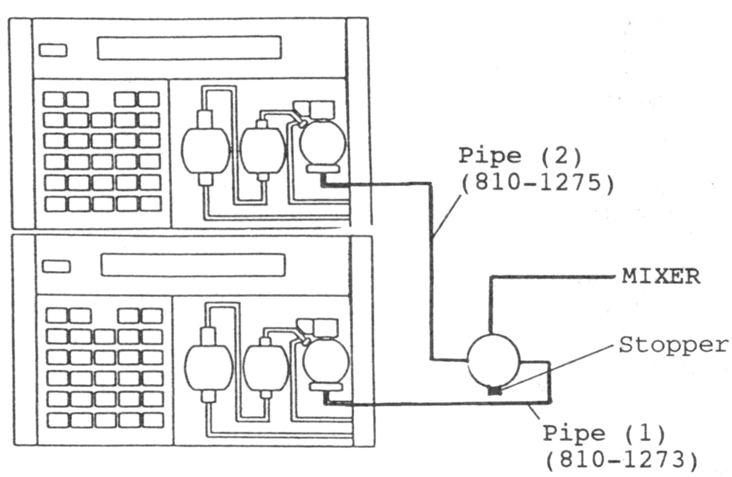
(g) Connect piping between each pump and the 4-way joint. Determine the connecting position of each pipe and attach it to the joint. In the two-liquid high pressure gradient system, attach the furnished stopper at the position on the joint where a pipe is not connected.

1) In case of three-liquid high pressure gradient system

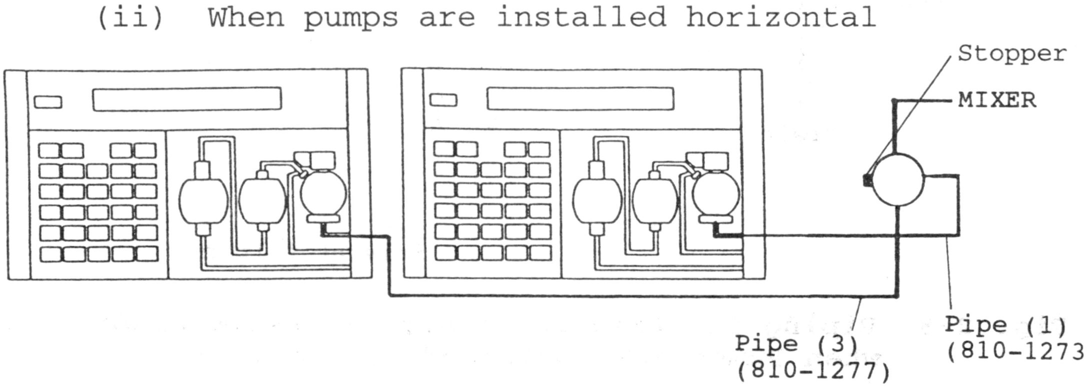


2) In case of two-liquid high pressure gradient system

(i) When pumps are installed vertical



(ii) When pumps are installed horizontal



(h) Attach the covers to the pumps.

After installing the high pressure gradient system, carry out piping for the two-liquid gradient system as in Figure 2-8 or 2-9, or for the three-liquid gradient system as in Figure 2-10.

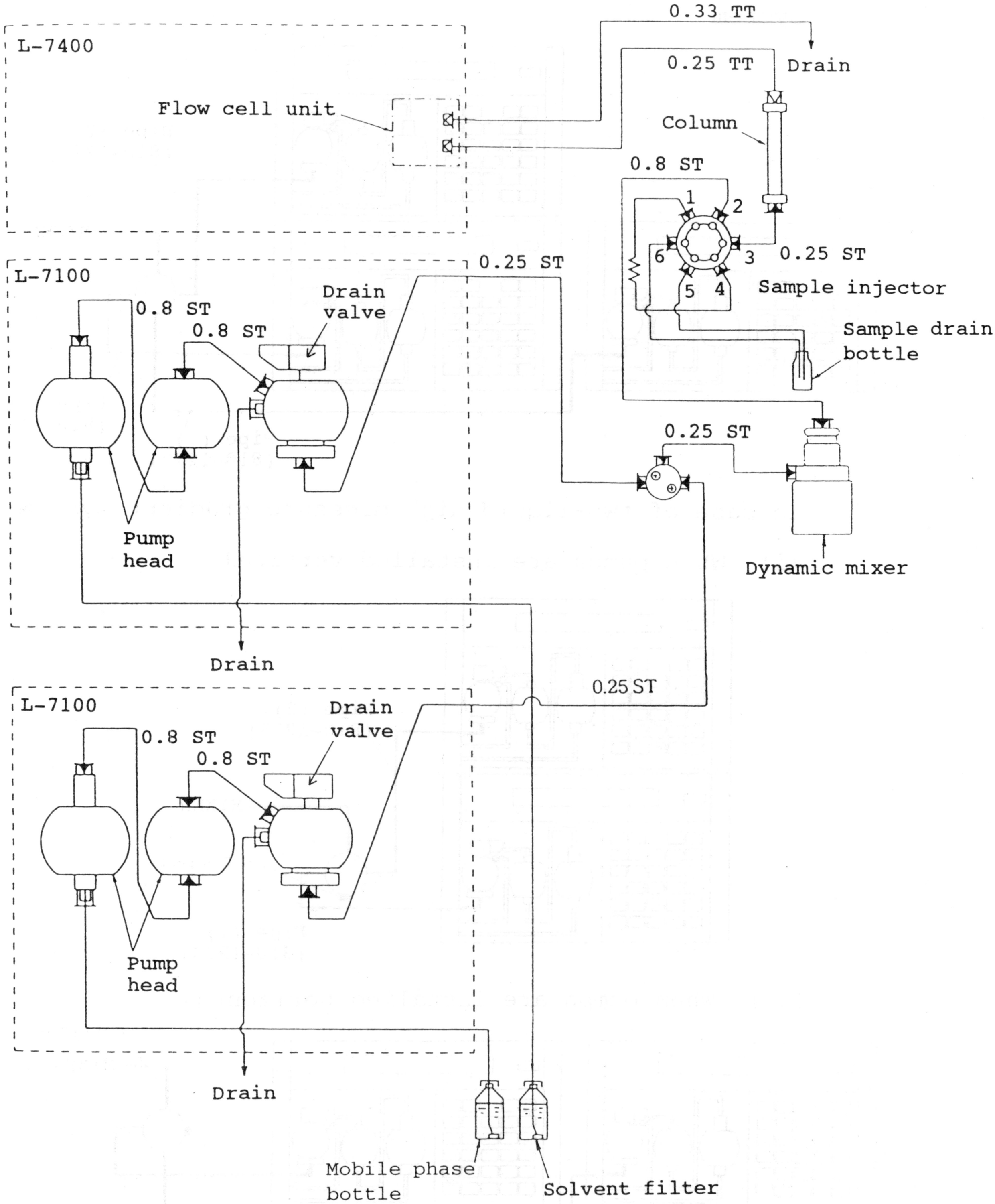


Fig. 2-8 Piping for Two-liquid High Pressure Gradient System, when Pumps are Installed Vertical

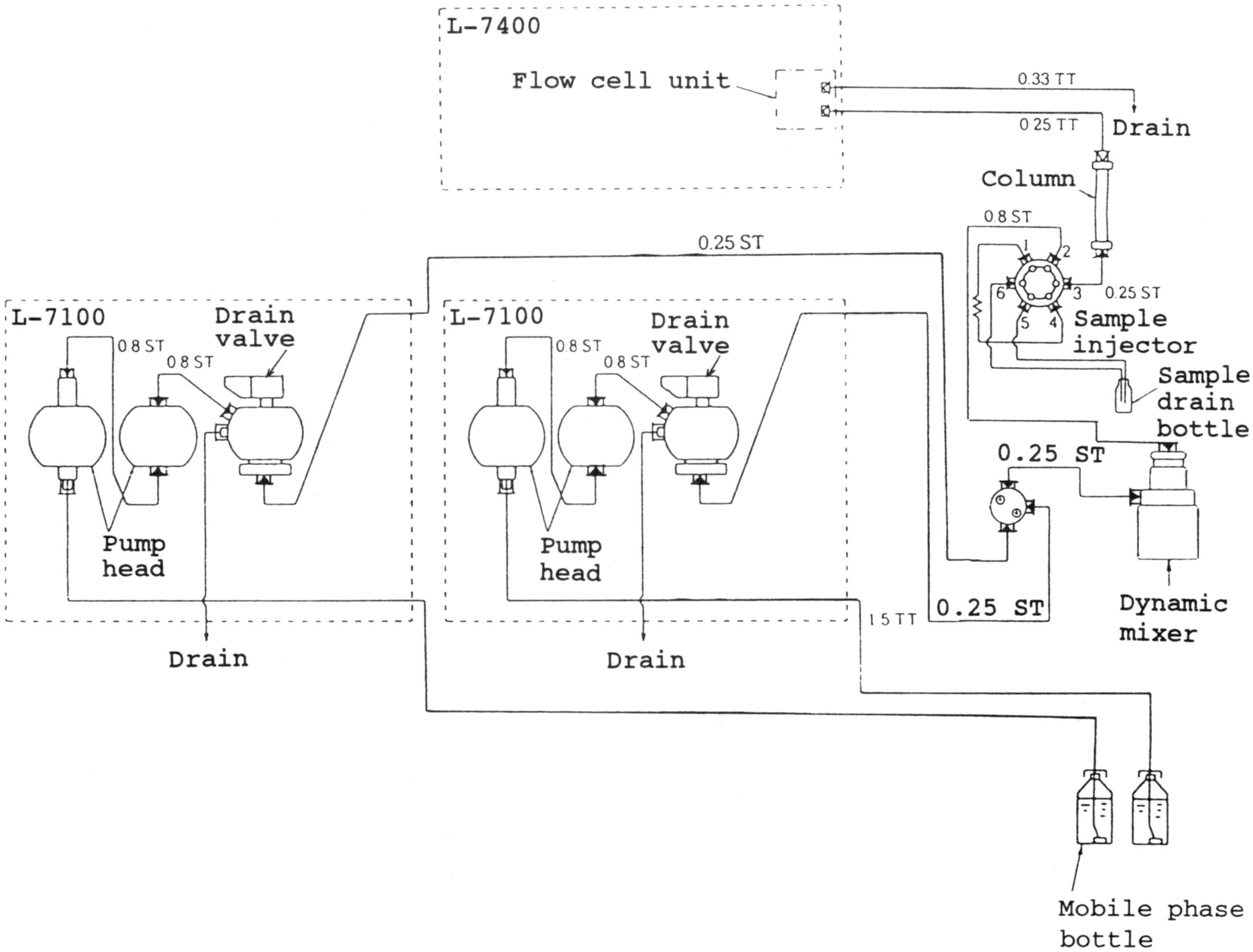


Fig. 2-9 Piping for Two-liquid High Pressure Gradient System, when Pumps are Installed Horizontal

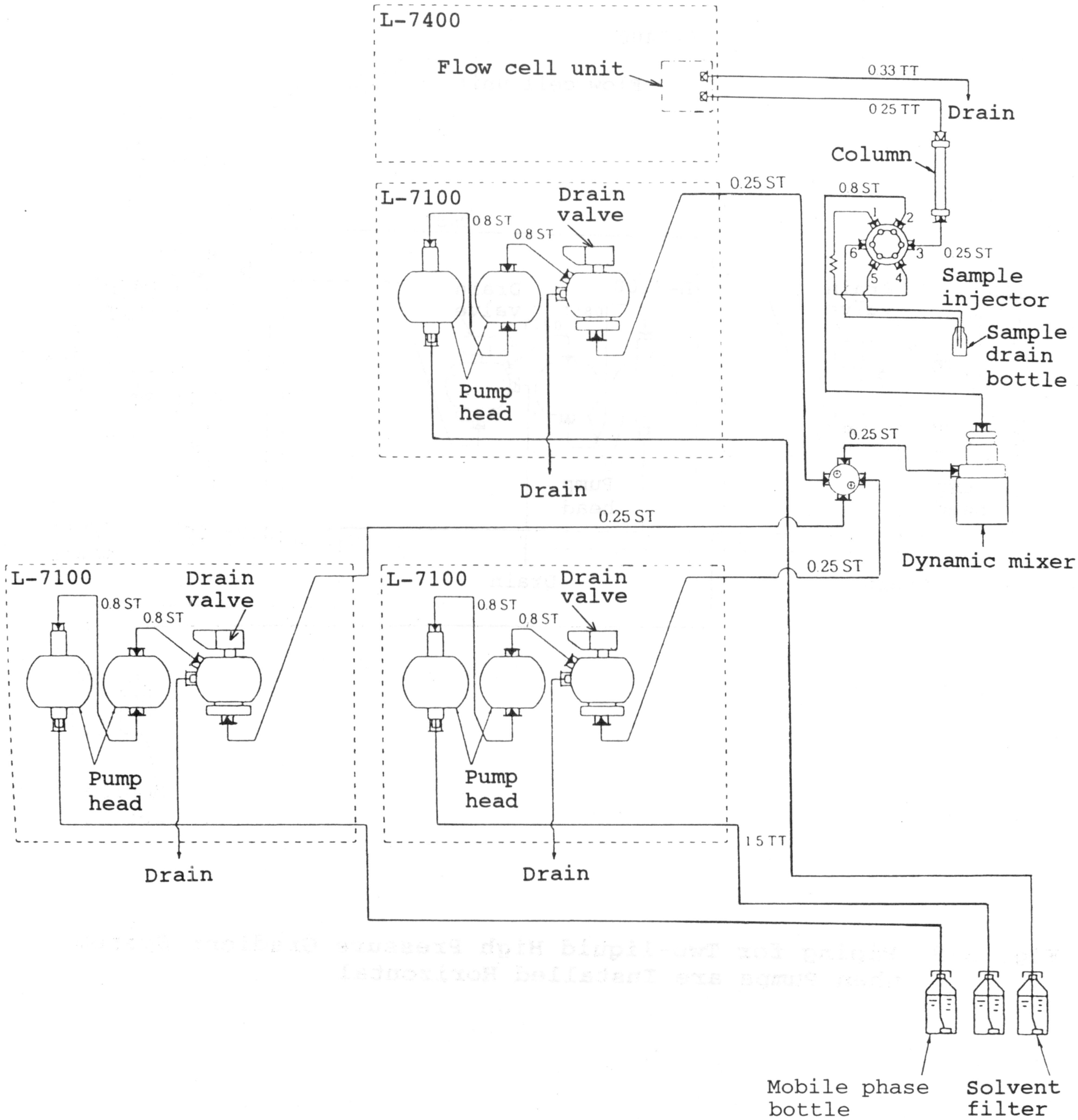


Fig. 2-10 Piping for Three-liquid High Pressure Gradient System

2-2-4 Method of Tubing

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

⚠ WARNING

Beware of Electric Shock!

Potentially Dangerous Voltages are Present within the Instrument.

Before removing the instrument cover for replacement or adjustment of inside parts, be sure to turn OFF the power switch and unplug the power cord.

(1) Attachment of the Inlet Tube

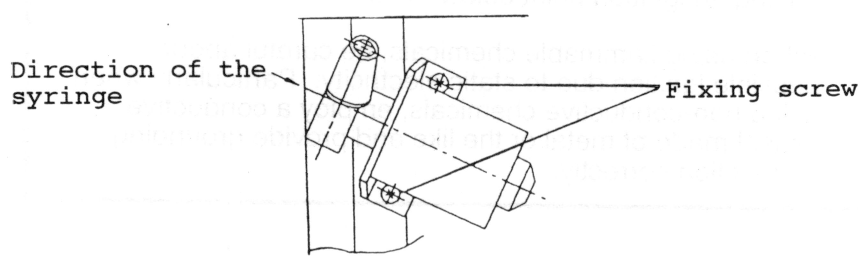
(a) Tighten completely the inlet tube by hand.

NOTICE:	Do not use a tool. Use of any tool may shorten the life of the tube tip or ferrule.

(b) Place the mobile phase inlet tube filter completely in contact with the bottom of the mobile phase bottle.

(2) Mounting the Sample Injector

Using the two fixing screws that come with the injector, secure the sample injector at the right front position on the pump. Pay special attention to the correct orientation of the injector.



(3) Tubing Flow Path

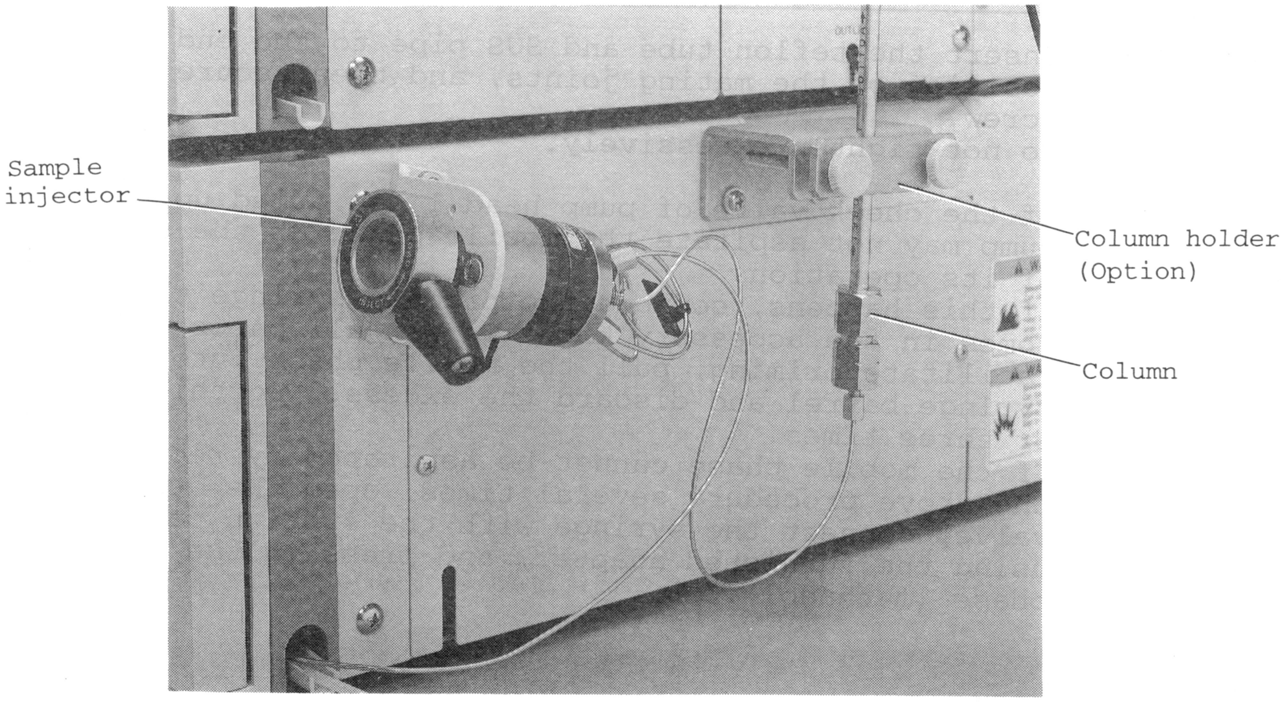
Connect the tubing securely to avoid leaks. Follow the tubing diagram given in each system.

(4) Column Connections

(a) Connect the column. Ensure that the mobile phase flow through the column follows the direction suggested by the manufacturer.

(b) When the flow direction is not specified, hold the column so you can read the label from left to right and install the column so that the mobile phase enters from the left as you read the columm label.

(c) Using the column holder (option), mount the column at the center right position on the pump.



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(5) Detector OUTLET Tube

Never cut the OUTLET tube of the detector. The OUTLET tube length prevents flow pulsations that result from bubbles coming out of the solvent at the low pressure end. These pulsations will affect the baseline stability of the detector and will appear as noise.

(6) Waste Solution

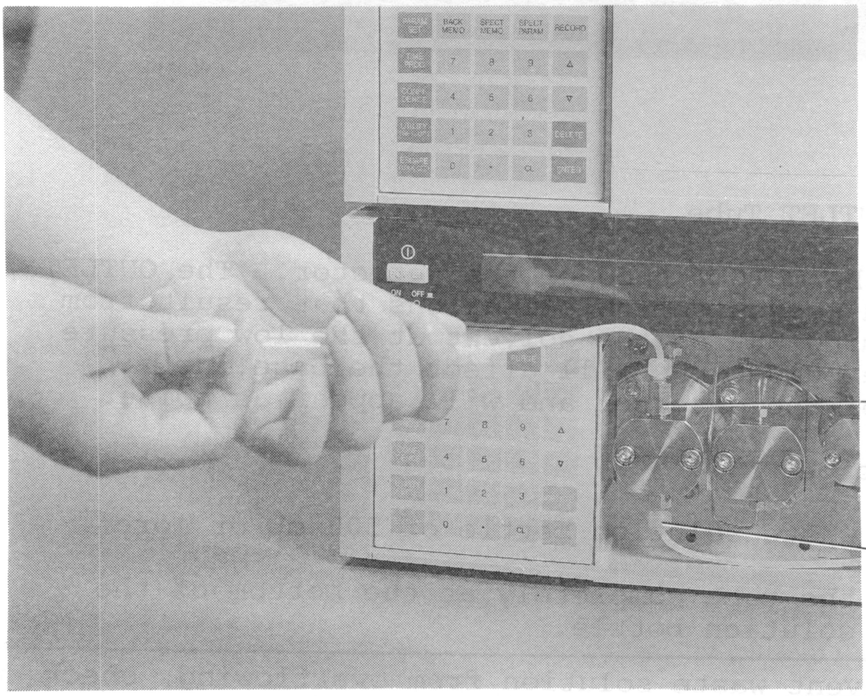
(a) Use a waste solution bottle of 500 mL or more.

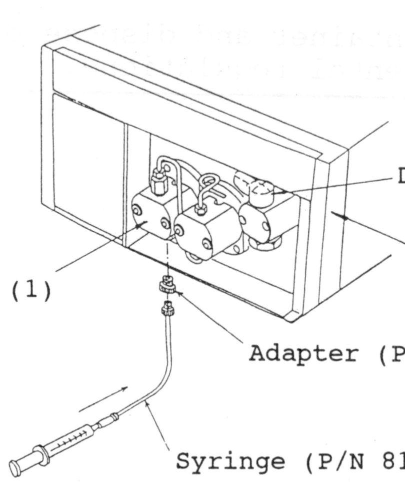
(b) Place the tube completely at the bottom of the waste solution bottle.

NOTICE: To prevent waste solution from overflowing, check its volume frequently.
Empty the waste container and dispose of solvent following environmental regulations.

NOTICE 1: Insert the teflon tube and SUS pipe to the end position of the mating joints, and then secure each screw.
Do not tighten excessively.

NOTICE 2: If the check valve of pump head 1 has dried up, the pump may not aspirate the mobile phase at the start of its operation.
If this happens, connect the priming syringe that comes in the accessory kit. To wet all parts and facilitate priming, pull the mobile phase into the syringe barrel and discard the excess. Do this two or three times.
If the mobile phase cannot be aspirated by repeating the above procedure several times, open the drain valve, connect the syringe with the suction port using the furnished adapter, and press in the mobile phase (methanol).



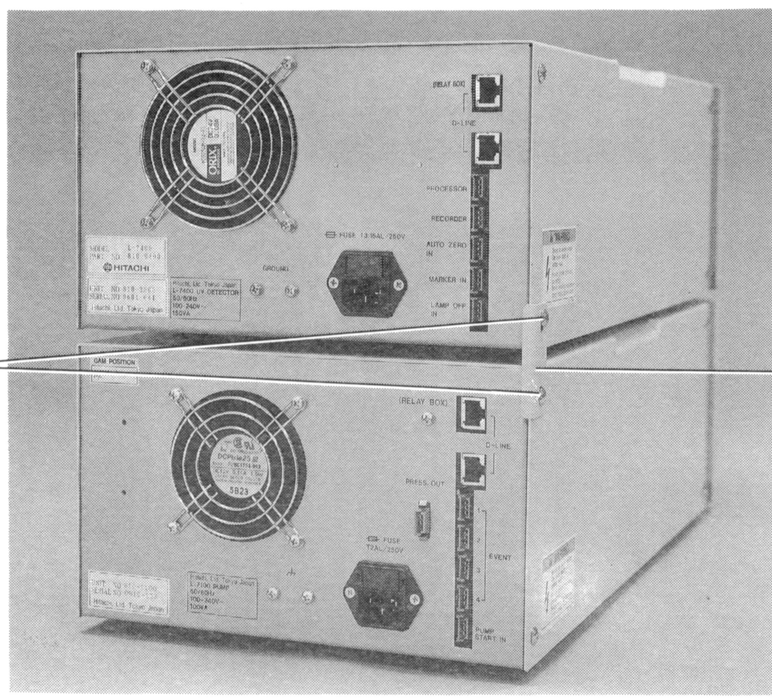


2-3 Fastening between Component Units

You can stack the Model L-7100, Model L-7400 UV detector, Model L-7200 autosampler, etc., to save bench space. Each module fastens to each other via a fastening plate to prevent them from falling in the event of an earthquake or any other disturbance. To fasten the units, do the following:

(1) Remove the two adjacent cover fastening screws in the side panels that are shown below.

(2) Attach the fastening plate with the screws you just removed.



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2-4 Setting up D-line Communication Function

The D-line is Hitachi's unique communication network for automating a liquid chromatograph system. An automated liquid chromatograph system can be set up easily by connecting pumps and other accessories to a data processor or integrator via the D-line. Refer to **"Communication" in Section 10**.

3. FUNCTIONS

Table of Contents

Table of Contents (cont'd)

3. FUNCTIONS

The Model L-7100 is a pump which plays a major role in the Hitachi high performance liquid chromatography system. This section describes the functions of this pump.

3-1 Front Panel Operating Section of Pump

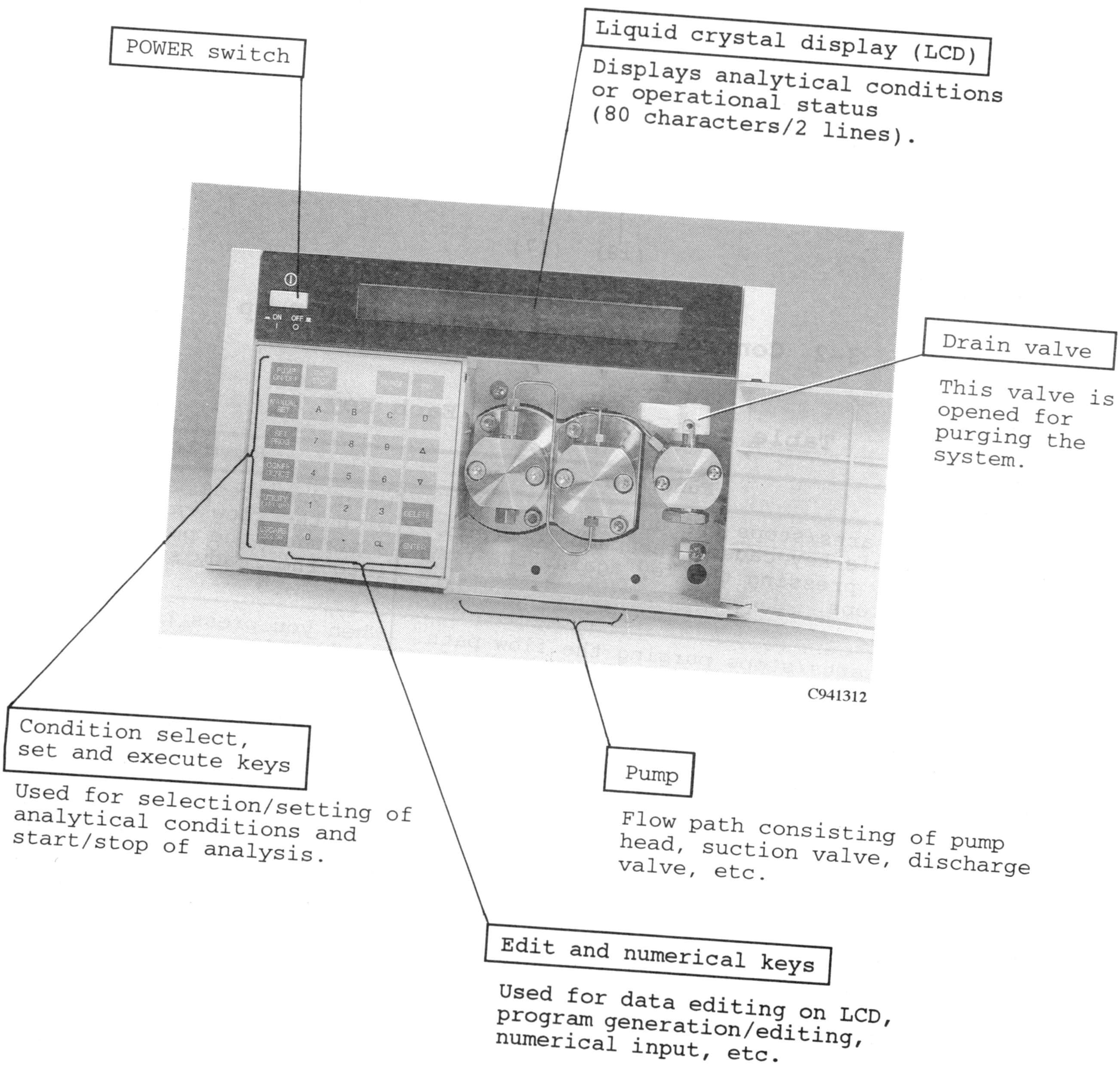


Fig. 3-1 Front View of the Model L-7100 Pump

3-2 Function of Each Key

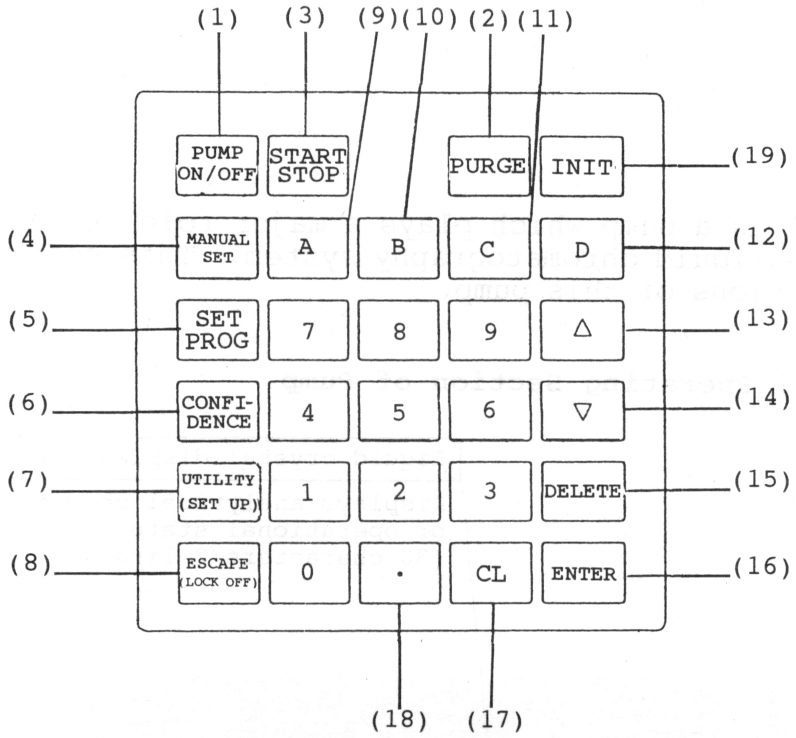


Fig. 3-2 Control Panel of Model L-7100 Pump

Table 3-1 Function of Each Key

No.	Key	Function	Remarks
1	PUMP ON/OFF	Starts/stops the pump. Pressing this key causes the pump to start. By pressing the key again, the pump stops.	When you press this key with the flow rate set to 0 mL/min, the pump goes into the ready status.
2	PURGE	Starts/stops purging the flow path. Upon pressing this key, the pump establishes the following conditions. Maximum flow rate: 9.999 mL/min PRESS MAX: 2.9 MPa (30 kg/cm^2, 427 psi) MIN: 0 MPa (0 kg/cm^2, 0 psi)	When you press the key again, the unit stops purging. **NOTICE:** Be sure to set the drain valve at OPEN for purging. Otherwise liquid delivery will stop upon reaching upper pressure limit.
3	START STOP	Starts/stops pump program. You can activate the start key only when the pump is at the initial conditions and the monitor screen shows in the LCD.	If the LCD displays the monitor screen, switch to the monitor screen by pressing ESCAPE key.

(cont'd)

No.	Key	Function	Remarks
4	MANUAL SET	Selects manual operation. It is also used for the display and setting of parameters (FLOW, P-MAX, P-MIN, mixing ratio of mobile phases).	When you press this key, the status parameters that were present prior to the pressing of this key remain active.
5	SET PROG	Selects, generates, edits, or deletes a pump program.	When you use this key from manual operation, you need to press the INIT key at first.
6	CONFI DENCE	Selects confidence data. 1) Indicates and sets the date of pump seal replacement. This key will also display the time of an error event. 2) Designates a key lock.	The key lock function can be reset by pressing the ESCAPE key.
7	UTILITY (SET UP)	1) Used for indicating and setting the auxiliary functions.(UTILITY) 1 = Compensation for the pressure zero point 2 = Assignment of the pressure unit 3 = Printout of a program 4 = Printout of a gradient curve 5 = Setting of the column flush 6 = Input of an event code 7 = Setting of the link program 2) Use for the pump drive mode selection. The pump modes are: Low pressure gradient mode High pressure gradient mode Single-liquid delivery pump mode D-line selection (SET UP)	1) At power-on, pump drive mode selection can be made by pressing this key. If this key is not pressed at power-on, the pump is started in the previous mode. 2) When pressing the POWER and UTILITY (SET UP) keys simultaneously, the pump mode setting screen appears. It may be necessary to continue pressing the UTILITY(SET UP) key until the setting screen appears.
8	ESCAPE (LOCK OFF)	Returns to the monitor screen from the numerical input mode. Returning to the monitor screen takes place when making entries in the gradient mode, etc.	The key lock function can be reset by pressing this key.

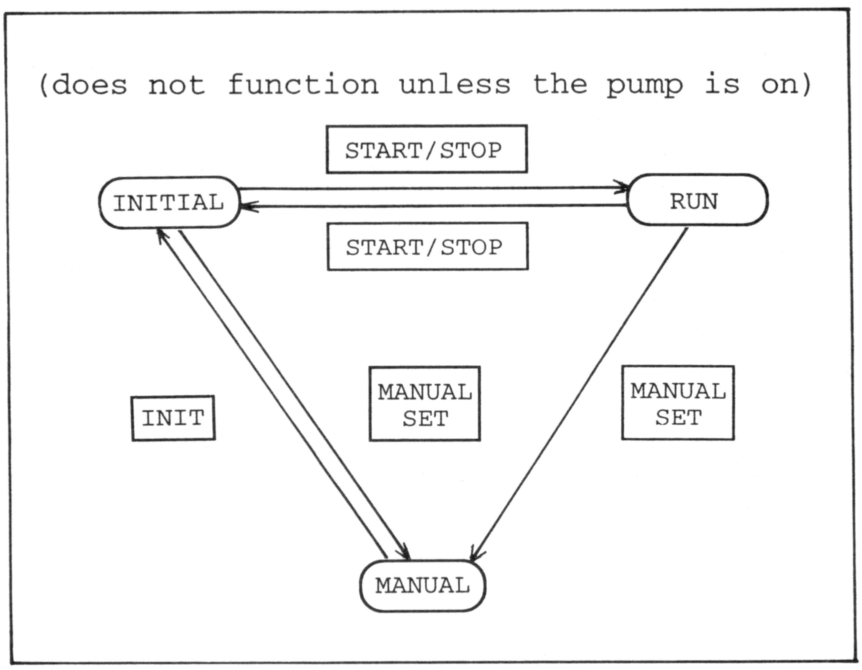
(cont'd)

No.	Key	Function	Remarks
9 10 11 12	A B C D	If you are in the manual status and you press the [A] key, %A is set immediately to 100. [B], [C] and [D] keys provide the same function.	The available keys vary depending upon the mode chosen. ● Low pressure gradient mode: The A, B, C and D keys available ● 3-liquid high pressure gradient mode: The A, B and C keys ● 2-liquid high pressure gradient mode: The A and B keys
13	Δ	1) Pressing this arrow key reverses the program by one step. 2) Use to select monitor display, etc.	
14	∇	1) Pressing this arrow key advances the program by one step. 2) Use to select monitor display, etc.	
15	DELETE	Used to erase each step of a pump program.	
16	ENTER	Registers input of numerals.	Be sure to press the [ENTER] key after making a numerical input.
17	CL	1) Clears the entry of numerals prior to pressing the [ENTER] key. 2) Clears error messages.	Stops the alarm sound.
18	●	Inputs the decimal point. Does not need to be preceded by "0".	
19	INIT	Puts the system to the initial setting of a program whose no. is selected by the [SET PROG] key (time program: 0 minutes)	

3-3 Operational Status

Fig. 3-3 is a flow chart that shows the transition of operational status. (indicates depression of a key.)

Turning on power



INITIAL : Programming mode status in which system waits for start.
MANUAL : Operation is made under constant conditions without using program.
RUN : Gradient mode is executed.

Fig. 3-3 Operational Status Transition

3-4 Initialization Screen

When turning on the power of the Model L-7100 pump, the intialization screen and/or D-line connection screen (when D-line is set) appears. Then, the monitor screen for the set pump mode follows.

```
POWER ON
    |   (Initialization and self-diagnosis are performed, and
    |   copyright is displayed.)
    v
D-LINE SYSTEM IS NOT READY.
    |   This screen remains displayed until D-line connection with
    |   other module is established. If D-line setting is OFF,
    |   this screen will not appear.
    v
TIME %A  %B %C %D  FLOW   PRESS        [--]
0.0  100 0  0  0   0.000  0.0            1
```

This is the initialization screen. Its contents vary according to the set mode. It is displayed in the same mode as when power was turned off previously.

3-5 Monitor Screen

During analysis, you can display the analytical status of your instrument in the LCD. We refer to this status display as the "monitor screen". An example of this display is shown next.

(1) 1st Monitor Screen

```
TIME %A %B %C %D FLOW  PRESS            [--]
0.0  100 0  0  0 0.000 0.0                1
```

The items shown in this screen are:

Display	Explanation
TIME	Time lapse of program
%A	Mixing ratio of liquid A
%B	Mixing ratio of liquid B
%C	Mixing ratio of liquid C
%D	Mixing ratio of liquid D
FLOW	Flow rate of pump
PRESS	Pump pressure
--	Pump status display

For the three-liquid high pressure gradient mode of PUMP A, %D does not display. For the two-liquid high pressure gradient mode of PUMP A, %C and %D do not display. For the single-liquid delivery gradient mode of pump, %A, %B, %C and %D do not display.

Following is an explanation of the status indication at the top right of the monitor screen.

[GR] ... Gradient program is under execution.
[IN] ... Liquid is being delivered under initial conditions of programming status.
[--] ... Pump is stopped in programming mode status.
[MN] ... Indicates manual mode.
[PG] ... Purge is under execution.
[LK] ... Keyboard on control panel is locked.
[PR] ... L-7100 program, gradient curve, or logbook is under printing at D-7500.
[FL] ... Column flushing is under execution.
[LC] ... Link program conditioning is under execution.

The status display is as follows.

Table 3-2 Status Display

Input Key \ Status		Pump ON	Pump OFF
GRADIENT	**START**	GR	None
	STOP	IN	--
MANUAL SET		MN	MN
PURGE		PG	None
KEY LOCK		LK	LK
PRINT		PR	PR
COLUMN FLUSH		FL	--
LINK CONDITIONING		LC	None

(2) 2nd Monitor Screen

```
P-UNIT     P.MAX     P.MIN              [--]
   MPa      41.2       0.0                 1
```

The display items on this screen are:

Display	Explanation
P-UNIT	Indicates the unit of pressure. You can display pressure in bar, kgf/cm^2, psi or MPa. The utility function allows you to select the pressure units.
P.MAX	Indicates the upper perssure limit. If pressure rises beyond the set level, the pump automatically stops.
P.MIN	Indicates the lower pressure limit. If pressure falls below the set level, teh pump automatically stops.

(3) 3rd Monitor Screen

EVENT	1	2	3	4	PUMP	FLUSH	[--]
	OFF	OFF	OFF	OFF	A	ON	1

The contents of the timer output, pump mode, and column flush setting show on this screen.

Display	**Explanation**
EVENT	Indicates the status of each EVENT terminal (1 to 4). ON indicates that contact is closed and OFF indicates that contact is open.
PUMP	Indicates pump station number (No.). Pump station No. is given as PUMP A, B, or C.
FLUCH	Indicates setting of column flush. When column flush is set, ON shows, and OFF shows when column flush is not set.

(4) 4th Monitor Screen

LINK PROG	STEP	CYCLE		[--]
ON	1	1/99		1

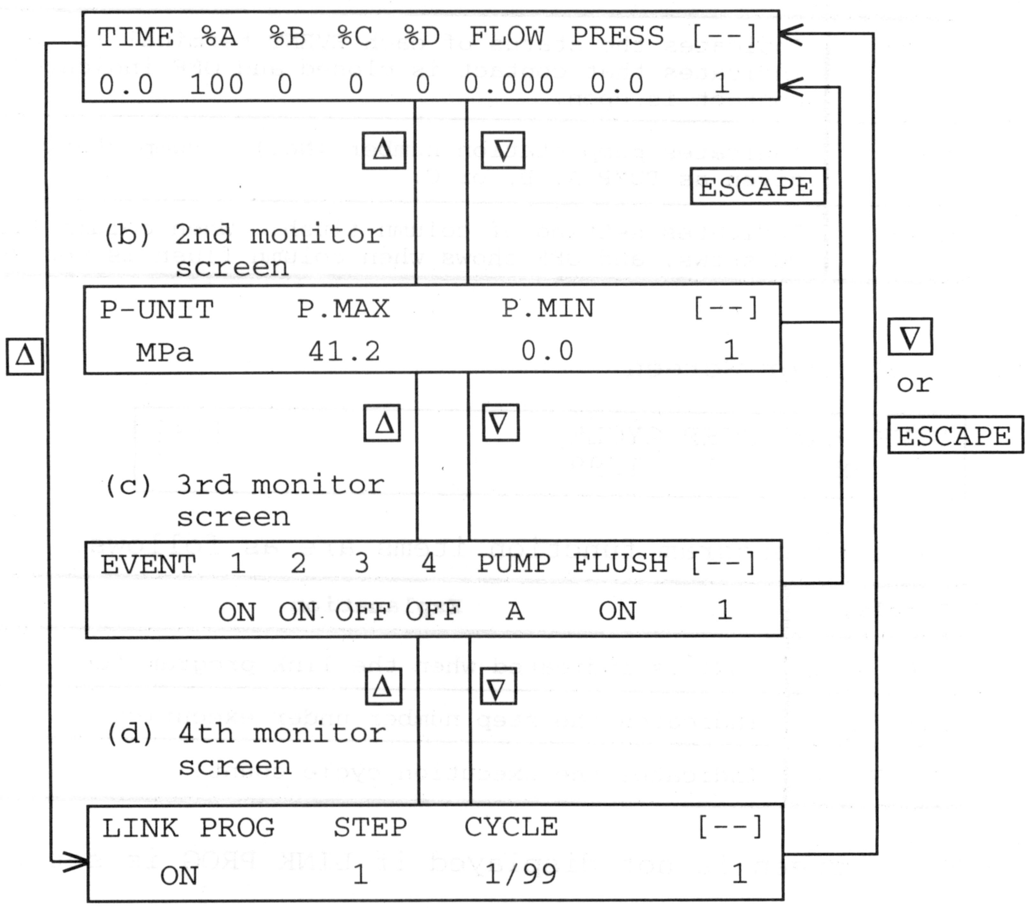
The link program function items are as follows:

Display	**Explanation**
LINK RPOG	'ON' is indicated when the link program function is used.
STEP	Indicates the step number under execution.
CYCLE	Indicates the execution cycle count.

This screen is not displayed if LINK PROG is set to 'OFF'.

The monitor screen transition is as follows. If the link program function is OFF, the 4th monitor screen will not appear.

(a) 1st monitor screen



3-6 Single-liquid Delivery Mode

This section shows the operation of the Model L-7100 pump with a single solvent.

3-6-1 Setting of Pump Mode

> **NOTICE:** Once this setting is made, it is memorized and need not be carried out each time.

POWER ON + UTILITY (SET UP)

When pressing simultaneously the POWER and the UTILITY (SET UP) keys, the pump mode setting screen appears.
Then, hold down UTILITY (SET UP) key until the pump mode setting screen appears.

```
SET UP:    PUMP      MODE      D-LINE
            A        L.P.GR     OFF
```

ENTER

```
PUMP: PUMP A=1, PUMP B=2, PUMP C=3
<1-3>  1
```

Set the pump station No.
(Ex.: 1 ENTER)

```
GR MODE: LOW P.=1, HIGH P.=2, FLOW=3
<1-3>     1
```

Set pump mode to "single-liguid delivery".
3 ENTER

```
D-LINE: OFF=0, ON=1
        1
```

Select the D-line.
(Ex.: 1 ENTER)

```
SET UP:  PUMP     MODE     D-LINE
          A      L.P.GR      ON
```

POWER OFF

Turn the power off once.

POWER ON

Turn the power on again.

Self-diagnosis is carried out.

```
D-LINE SYSTEM IS NOT READY
```

The D-line connection screen appears when D-line has been chosen in the configuration. If D-line setting is OFF, this screen will not appear.

```
TIME            FLOW     PRESS        [--]
0.0             0.000    0.0          1
```

3-6-2 Programming Operation

This section shows the programming for the single-liquid delivery mode. An example is given where upper pressure limit is 41.2 MPa, lower pressure limit is 0 MPa, analysis time is 0 min, and flow rate is 1.0 mL/min, and after pulse signal is output at event contacts 1 to 4, flow rate is increased to 2.0 mL/min up to analysis time of 10 min.

```
PROGRAM No.  =  1

PRESSURE VALUE :  MAX    MIN            MPa
                  41.2   0.0

   TIME                CONCENTRATION          FLOW              EVENT
  (min)      %A                            (ml/min)      1    2    3    4

   0.0      100                             1.000       12   22   32   42
  10.0      100                             2.000
```

Monitor screen

In case of manual setting screen, press [INIT] key to call out the programming screen.

[SET PROG]

Start the program generation.

```
SET PROGRAM:   No.                          [--]
<1-9>          1
```

Input program No. You can choose a program No. from 1 to 9.
(Ex.: [1] [ENTER])

```
MODIFY=0, NEW=1                             [--]
          0
```

Selects a new program or allows modification of a program.
(Ex.: [1] [ENTER])

```
PRESSURE:  MAX    MIN                        [--]
           41.2   0.0                          1
```

Input the upper and lower limit pressure values.
(Ex.: [4] [1] [.] [2] [ENTER] [0] [ENTER])

```
TIME                 FLOW       EVENT        [--]
0.0                  0.000                    1
```

Input time, flow rate and event. Up to 4 entries can be made for event. Input the events to be executed within the entered time. See section 3-9-7 for the event function.

(Ex.: [0] [ENTER] [1] [ENTER] [1] [2] [ENTER] [2] [2] [ENTER] [3] [2] [ENTER] [4] [2] [ENTER])

With the above operation, 0.0 is entered for TIME, 1.000 for FLOW, and 12, 22, 32, 42 for EVENT.

```
TIME                 FLOW       EVENT        [--]
_                                             1
```

A new input screen will appear, so enter time, flow rate and event.

(Ex.: [1] [0] [ENTER] [2] [ENTER] [ENTER] [ENTER] [ENTER] [ENTER])

With the above operation, 10.0 is entered for TIME and 2.000 is entered for FLOW.

[ESCAPE]

Monitor screen

NOTICE:	A total of 99 steps can be entered for program Nos. 1 to 9.

NOTICE:	The input program is stored. When power is turned on next time, the initial screen (TIME=0.0) for the program used just before power was turned off will appear.

3-6-3 Manual Operation

This is used for supplying mobile phase under constant conditions without using a program.

(1) Constant Flow Rate Mode

This section explains the setting of the liquid delivery system at a constant flow rate. An example is given where flow rate is 1.0 mL/min, upper pressure limit is 41.2 MPa and lower pressure limit is 0 MPa.

Monitor screen

MANUAL SET

```
MANUAL: FLOW=1, PRESS=2                          [MN]
<1-2>     1
```

Select the constant flow rate mode.
[1] [ENTER]

```
 CONSTANT FLOW: FLOW  MAX   MIN              [MN]
                1.000 41.2  0.0
```

Input flow rate, and the upper and lower limit pressure values.
(Ex.: [1] [ENTER] [4] [1] [.] [2] [ENTER] [0] [ENTER])

```
CONSTANT FLOW:  FLOW    PRESS                 [MN]
                0.000   0.0
```

The monitor screen will appear.

NOTICE:	The set conditions for manual operation will be erased when power is turned off. The conditions must be set each time power is turned on.

(2) Constant Pressure Mode

This section explains the setting of the liquid delivery system at a constant pressure. An example is given where liquid is delivered at a pressure of 39.2 MPa.

Monitor screen

[MANUAL SET]

```
MANUAL:  FLOW=1, PRESS=2              [MN]
<1-2>    1
```

Select the constant pressure mode.
[2] [ENTER]

```
CONSTANT PRESS:    PRESSURE           [MN]
                   39.2
```

Input a pressure value. The valid range for pressure values is from 2 to 39.2 MPa (29 to 5685 psi).
(Ex. [3] [9] [.] [2] [ENTER])

```
CONSTANT PRESS:    FLOW   PRESS       [MN]
                   0.000   0.0
```

NOTICE:	In order to avoid a sudden application of pressure when the pump is started for column packing in the constant pressure mode, liquid delivery will not start unless the starting pressure is 0 MPa.

NOTICE:	The set conditions for manual operation will be erased when power is turned off. The conditions must be set each time power is turned on.

Before starting the pump, check that the pressure level is 0 MPa.
When changing the setting, turn off the pump to make the pressure indication 0 MPa. If the setting is changed without taking the above step, the pump control condition remains unchanged though the on-screen indication is changed

3-6-4 Analytical Operation

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

When the settings are all finished, carry out operation in the following procedure.

(1) Make sure the pump, column, detector and data processor are properly connected.

(2) Set the mobile phase and waste solution bottle in place.

(3) Start the pump and wait until the flow path is filled with mobile phase.

(4) Warm up the pump, column and detector and wait until the baseline stabilizes.

(5) Inject a sample.

(6) When analysis is finished, turn the power off and dispose of the waste solution.

NOTICE:	Before connecting a new column, be sure to fill the flow path with mobile phase so that air won't enter the column.

NOTICE:	The whirring sound of the pump during operation varies depending on such operating conditions as flow rate and pressure. Although the whirring sound may become larger anywhere in the high-pressure range, it is not a symptom of abnormality.

3-7 Low Pressure Gradient Mode

Explained here is the operating method for using the L-7100 pump in the low pressure gradient mode.

3-7-1 Setting of Pump Mode

This section shows how to set the pump in the low pressure gradient mode.

NOTICE: Once this setting is made, it is memorized and need not be made each time.

(POWER ON) + [UTILITY (SET UP)]

When pressing the [POWER] and [UTILITY (SET UP)] keys simultaneously, the pump mode setting screen appears. It may be necessary to continue pressing [UTILITY (SET UP)] until the setting screen appears.

```
SET UP:    PUMP     MODE      D-LINE
            A      L.P.GR      OFF
```

[ENTER]

```
PUMP:   PUMP A=1,   PUMP B=2,   PUMP C=3
<1-3>   1
```

Set the pump station No.
(Ex.:[1][ENTER])

```
GR MODE:   LOW P.=1,   HIGH P.=2,   FLOW=3
<1-3>      1
```

Set the pump mode to "low pressure gradient".
[1][ENTER]

```
D-LINE:   OFF=0,   ON=1
          1
```

Select the D-line.
(Ex.:[1][ENTER])

```
SET UP:  PUMP    MODE    D-LINE
           A     L.P.GR    ON
```

POWER OFF

Turn off power once.

POWER ON

Turn on power again.

Self-diagnosis is carried out.

```
D-LINE SYSTEM IS NOT READY
```

The D-line connection screen appears when D-line has been chosen in the configuration. If D-line setting is OFF, this screen will not appear.

```
TIME   %A   %B   %C   %D   FLOW    PRESS   [--]
0.0    100  0    0    0    0.000   0.0       1
```

3-7-2 Setting of Low Pressure Gradient Type

When determining a configuration of low pressure gradient system, select the kind of mixer, provision/non-provision of degasser, gradient type, etc. according to the kind and flow rate of solvent. In general, the capacity of mixer should be larger as the flow rate is higher. For mixture of sparingly mixable solvent, prepare a mixer having a large capacity. To enhance accuracy of mixing ratio for ensuring good reproducibility in analysis, it is recommended to use a degasser. As an example, the following table shows the water-methanol mixing system configuration and the flow rate range.

> **NOTICE:** For control of low pressure gradient operation, the FAST-type or SLOW-type gradient operation is available. The former provides higher gradient response, and the latter provides higher gradient accuracy.
> It is recommended to use the low pressure gradient types selectively as listed below. SLOW type is normally used. Select FAST type when using a mobile phase which is difficult to mix. Optimum usage varies with kind of mobile phase, etc. So, match type selection with the mobile phase to be used.

(1) With Degasser

	Flow Rate Range (mL/min)	
	SLOW	**FAST**
Without mixer	-	0.1 to 0.3
Static mixer	0.1 to 2.0	0.3 to 4.0
Dynamic mixer	1.0 to 4.0	4.0 to (7.0)*
Staic mixer + dynamic mixer	1.0 to 4.0	4.0 to (9.999)*

* The Model L-7610 degasser is usable at a flow rate of 5.0 mL/min or less. The dash '-' in the table indicates that setting is not recommended.

(2) Without Degasser (air bubbles may form in flow path and cause unstable baseline)

	Flow Rate Range (mL/min)	
	SLOW	**FAST**
Without mixer	-	-
Static mixer	0.1 to 2.0	-
Dynamic mixer	1.0 to 4.0	-
Static mixer + dynamic mixer	1.0 to 4.0	4.0 to 9.999

The dash '-' in the table indicates that setting is not recommended.

NOTICE 1: The static mixer is included in the low pressure gradient unit.
NOTICE 2: The dynamic mixer is available optionally.

Monitor screen

UTILITY (SET UP)

UTILITY: COND.=1, UNIT=2, PRINT=3, [--]
<1-6> 1 FLUSH=4, EVENT=5, LINK=6

Select COND.(CONDITION SET).
1 ENTER

CONDITION SET: Z-ADJ=1, M.CONTROL=2, [--]
<1-3> 1 L.P.GR.TYPE=3

Select L.P.GR.TYPE.
3 ENTER

L.P.GRADIENT TYPE: SLOW=1, FAST=2 [--]
1

Select low pressure gradient type.
(Ex.: 1 ENTER)

Monitor screen

NOTICE: Once the low pressure gradient type is set, it is memorized and need not be set each time.

3-7-3 Programming Operation

This section discusses the programming of the low pressure gradient mode. An example is given where upper pressure limit is 41.2 MPa, lower pressure limit is 0 MPa, analysis time is 0 min, liquid B 10%, liquid C 0%, liquid D 0% and flow rate is 1.0 mL/min. After pulse signal is output at event contacts 1 to 4, change is made to liquid B 20%, liquid C 0%, liquid D 0% at flow rate of 1.0 mL/min up to analysis time of 10 min.

PROGRAM No. = 1

PRESSURE VALUE : MAX 41.2 MIN 0.0 MPa

TIME		CONCENTRATION			FLOW	EVENT			
(min)	%A	%B	%C	%D	(ml/min)	1	2	3	4
0.0	90	10	0	0	1.000	12	22	32	42
10.0	80	20	0	0	1.000				

Monitor screen

If manual setting screen is displayed, press [INIT] to obtain the programming mode.

[SET PROG]

Program generation is started.

```
SET PROGRAM: No.                [--]
<1-9>          1
```

Input program No. Valid program numbers are from 1 to 9.
(Ex.: [1] [ENTER])

```
MODIFY=0, NEW=1                 [--]
          0
```

Generates a new program or modifies an existing program.
(Ex.: [1] [ENTER])

```
PRESSURE:     MAX       MIN     [--]
              41.2      0.0      1
```

Input the upper and lower limit pressure values.
(Ex.: [4] [1] [.] [2] [ENTER] [0] [ENTER])

```
TIME   %B   %C   %D   FLOW    EVENT           [--]
_0.0   0    0    0    1.000                    1
```

Input time, solvent mixing ratio, flow rate and event. The mixing ratio of solvent A is determined by subtracting the mixing ratio of solvent B + the mixing ratio of solvent C + the mixing ratio of solvent D.
Up to 4 entries can be made per step for event. Input an event to be executed within the entered time. See 3-9-7 for the event function.

(Ex.: [0] [ENTER] [1] [0] [ENTER] [0] [ENTER] [0] [ENTER] [1] [ENTER] [1] [2] [ENTER] [2] [2] [ENTER] [3] [2] [ENTER] [4] [2] [ENTER])

With the above operation, 0.0 is entered for TIME, 10 for %B, 0 for %C, 0 for %D, 1.000 for FLOW, and 12, 22, 32, 42 for EVENT.

```
TIME   %B   %C   %D   FLOW    EVENT           [--]
_                                              1
```

A new input screen will appear, so enter time, mixing ratios for solvents B, C, D, flow rate and event.

(Ex.: [1] [0] [ENTER] [2] [0] [ENTER] [0] [ENTER] [0] [ENTER] [1] [ENTER] [ENTER] [ENTER] [ENTER] [ENTER])

With the above operation, 10.0 is entered for TIME, 20 for %B, 0 for %C, 0 for %D, and 1.000 for FLOW.

[ESCAPE]

Monitor screen

NOTICE:	A maximum of 99 steps can be entered for program Nos. 1 to 9.

NOTICE:	The entered program is saved. When power is turned on next time, the initial screen (TIME=0) of the program used just before power was turned off will appear.

3-7-4 Manual Operation

This section covers the manual operation of the low pressure gradient mode. This is used when supplying liquid under constant conditions without using a program. An example is given where liquid B is set at 10%, liquid C at 0%, liquid D at 0%, flow rate at 1 mL/min, upper pressure limit at 41.2 MPa and lower pressure limit at 0 MPa.

Monitor screen

$\boxed{\text{MANUAL SET}}$

```
MANUAL: %B   %C   %D   FLOW    MAX    MIN   [MN]
        _ 0    0    0   1.000   41.2   0.0
```

Input the solvent mixing ratios, flow rate, and the upper and lower limit pressure values.

(Ex.: $\boxed{1}$ $\boxed{0}$ $\boxed{\text{ENTER}}$ $\boxed{0}$ $\boxed{\text{ENTER}}$ $\boxed{0}$ $\boxed{\text{ENTER}}$ $\boxed{1}$ $\boxed{\text{ENTER}}$ $\boxed{4}$ $\boxed{1}$ $\boxed{.}$ $\boxed{2}$ $\boxed{\text{ENTER}}$ $\boxed{0}$ $\boxed{\text{ENTER}}$)

Monitor screen

NOTICE: The set conditions for manual operation will be erased when power is turned off. Conditions must be set each time power is turned on.

3-7-5 Analytical Operation

WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

When the settings are all finished, carry out operation in the following procedure.

(1) Make sure the pump, column, detector and data processor are properly connected.

(2) Set the mobile phase and waste solution bottle in place.

(3) Start the pump and wait until the flow path is filled with the mobile phase.

(4) Warm up the pump, column and detector, and wait until the baseline stabilizes.

(5) Inject a sample.

(6) When analysis is finished, turn the power off and dispose of the waste solution.

NOTICE: Before connecting a new column, make sure the flow path is filled with mobile phase so that air won't enter the column.

NOTICE: The whirring sound of the pump during operation varies depending on such operating conditions as flow rate and pressure. Although the whirring sound may become larger anywhere in the high-pressure range, it is not a symptom of abnormality.

3-8 High Pressure Gradient Mode

The following explains the operation when using L-7100 pump in the high pressure gradient mode. The liquid delivery conditions in this mode are set using Pump A. Pumps B and C operate according to the conditions set with Pump A.

3-8-1 Setting of Pump Mode

This section shows how to set the pump in the high pressure gradient mode.

NOTICE:	Once these settings are made, they are memorized and need not be made each time.

(1) Pump A

POWER + UTILITY (SET UP)

When pressing the POWER and UTILITY (SET UP) keys simultaneously, the pump mode setting screen appears. It may be necessary to continue pressing UTILITY (SET UP) until the setting screen appears.

```
SET UP: PUMP   MODE    D-LINE
          A     L.P.GR  OFF
```

ENTER

```
PUMP: PUMP A=1, PUMP B=2, PUMP C=3
<1-3>  1
```

Set the pump station No. to "PUMP A".
1 ENTER

```
GR MODE: LOW P.=1, HIGH P.=2, FLOW=3
<1-3>      1
```

Set the pump mode to "high pressure gradient".
2 ENTER

```
D-LINE: OFF=0, ON=1
          1
```

Select the D-line.
(Ex.: 1 ENTER)

```
TYPE OF H.P.GRADIENT:
<2 or 3>          2
```

Choose the number of pumps that you will use in the high pressure gradient delivery system.
(Ex.: [3] [ENTER])

```
SET UP: PUMP  MODE   D-LINE
          A  H.P.GR   ON
```

POWER OFF

Turn the power off once.

POWER ON

Turn the power on again.
Self-diagnosis is performed.

```
D-LINE SYSTEM NOT READY
```

The D-line connection screen appears when D-line has been chosen in the configuration. If D-line setting is OFF, this screen will not appear.

```
TIME  %A     %B   %C   FLOW   PRESS    [--]
0.0  100.0  0.0  0.0  0.000  0.0        1
```

(2) Pump B, Pump C

POWER ON + UTILITY (SET UP)

When pressing the POWER and UTILITY (SET UP) keys simultaneously, the pump mode setting screen appears. It may be necessary to continue pressing UTILITY (SET UP) until the setting screen appears.

```
SET UP: PUMP   MODE    D-LINE
          A   L.P.GR    OFF
```

ENTER

```
PUMP: PUMP A=1, PUMP B=2, PUMP C=3
<1-3>  1
```

Set the pump station No. to "PUMP B" or "PUMP C". (Ex.: 2 ENTER)

```
GR MODE: LOW P.=1, HIGH P.=2, FLOW=3
<1-3>      1
```

Set the pump mode to "high pressure gradient".
2 ENTER

```
SET UP: PUMP    MODE    D-LINE
         B     H.P.GR    ON
```

POWER OFF

Turn the power off once.

POWER ON

Turn the power on again.

```
D-LINE SYSTEM IS NOT READY
```

```
PUMP B                          [--]
```

The monitor screen for Pump B or Pump C in the high pressure gradient mode appears. In case of Pump C, PUMP C will appear on the LCD.

3-8-2 Setting of Pump Motor Control Method

The pump motor control method (M.CONTROL) is selectable for use with the high pressure gradient mode. M.CONTROL is normally set to STANDARD. Since the STANDARD mode is an automatic flow rate control method, the system may be affected by pressure between the pumps depending on the usage conditions (high pressure gradient, reaction pump, etc.) and the baseline fluctuation may increase. This effect can be reduced by using the FIX mode, a constant flow rate control method. But if pressure variation is very large due to change of mixing ratio in the actual usage conditions, the baseline stability may worsen. The STANDARD mode is recommended in such case.

NOTICE:	Before selecting STANDARD or FIX mode, check the baseline stability under the actual analysis conditions.

The operating pressure and FIX setting of M.CONTROL with which minimum pressure variation (minimum baseline fluctuation) is obtained when using mobile phases of water, methanol and acetonitrile are shown in Figure 3-4. The input range for FIX STEP AREA is from 30 to 300. Check the pressure when supplying mobile phase and read out the FIX STEP AREA corresponding to the operating pressure from Figure 3-4.

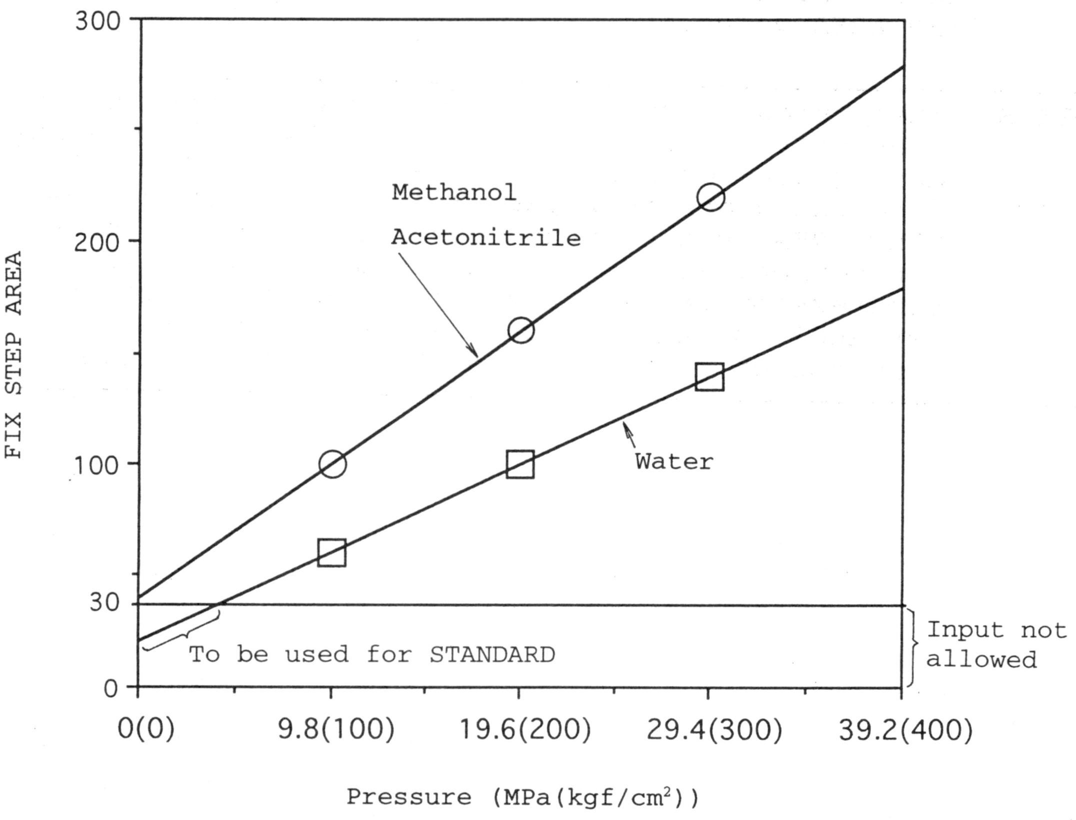


Fig. 3-4 FIX STEP AREA

(1) How to Adjust FIX STEP AREA
Read out a value from Figure 3-4, and enter it according to Item (3) - FIX STEP AREA Input Procedure.

(2) Fine Adjustment of FIX STEP AREA
To reduce baseline variation further, carry out fine adjustment as instructed below.

(a) Set M.CONTROL of pumps B and C to STANDARD.

(b) Set pump A alone to FIX, check the pressure during operation, and input a FIX STEP AREA determined from Figure 3-4.

(c) Supply liquid under the same conditions (mixing ratio, flow rate, column, etc.) as for actual analysis and check the pressure variation. (Check the output from PRESS.OUT terminal on the rear of L-7100 pump using the recording function of D-7500.)

(d) Change the FIX STEP AREA in steps of 5 to 10 and obtain the value with which the pressure variation is minimum.

(e) For FIX value setting for pumps B and C, set M.CONTROL of other pump to STANDARD, and determine the FIX STEP AREA with which pressure variation is minimum.

(f) After determining the FIX STEP AREA for each pump, set the M.CONTROL for all the pumps to FIX and enter the FIX STEP AREA value.

NOTICE: When using solvents other than water, methanol and acetonitrile as a mobile phase, check the pressure during use, obtain a hypothetical FIX STEP AREA value from the graph in **Figure 3-4**, and determine the FIX STEP AREA by the method described above. In obtaining a hypothetical FIX STEP AREA value, check if the compression rate of the solvent used is closer to methanol (high compression rate) or water (low compression rate) and use the resulting value.

(3) FIX STEP AREA Input Procedure

NOTICE: Once this setting is made, it is memorized and need not be made each time.

Monitor screen

↓ UTILITY (SET UP)

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6>  1 FLUSH=4, EVENT=5, LINK=6
```

↓ Select COND.(CONDITION SET).
[1] [ENTER]

```
CONDITION SET: Z-ADJ=1, M.CONTROL=2, [--]
<1-3>       1     L.P.GR.TYPE=3
```

↓ Select M.CONTROL (MOTOR CONTROL).
[2] [ENTER]

```
MOTOR CONTROL: STANDARD=1, FIX=2      [--]
<1-2>          1
```

↓ Select FIX.
[2] [ENTER]

```
FIX STEP AREA:                        [--]
<30-300>       100
```

Input the fix step area. An initial value of 100 is entered. Input is allowed within a range from 30 to 300. (Ex.: [7] [0] [ENTER])

3-8-3 Programming Operation

This section discusses the programming of the high pressure gradient mode. The liquid delivery conditions in this mode are set using pump A. Pumps B and C operate according to the liquid delivery conditions set with pump A. An example is given where the upper pressure limit is 41.2 MPa, lower pressure limit is 0 MPa, analysis time is 0 min, liquid B is 50%, liquid C is 25%, and flow rate is 1 mL/min. After pulse signal is output from event contacts 1 to 4, liquid B is changed to 10% and liquid C to 0% at flow rate of 1 mL/min up to analysis time of 10 min.

```
PROGRAM No.  =  1

PRESSURE VALUE :  MAX    MIN          MPa
                 41.2    0.0

   TIME               CONCENTRATION            FLOW           EVENT
   (min)       %A      %B       %C           (ml/min)    1    2    3    4

    0.0       25.0    50.0     25.0           1.000     12   22   32   42
   10.0       90.0    10.0      0.0           1.000
```

Monitor screen

If manual setting screen is displayed, press [INIT] key to obtain programming mode screen.

[SET PROG]

```
SET PROGRAM: No.                      [--]
             1
```

Input program No. Valid program numbers are from 1 to 9.
(Ex.: [1] [ENTER])

```
MODIFY=0, NEW=1                       [--]
          0
```

Selects a new program or allows modification of program.
(Ex.: [1] [ENTER])

```
PRESSURE:  MAX    MIN                 [--]
           41.2   0.0                   1
```

Input the upper and lower limit pressure values.
(Ex.: [4] [1] [.] [2] [ENTER] [0] [ENTER])

```
TIME   %B    %C    FLOW    EVENT        [--]
_0.0   0.0   0.0   0.000                  1
```

Input time, solvent mixing ratios, flow rate and event. The mixing ratio of solvent A is determined by subtracting the mixing ratio of solvent B + the mixing ratio of solvent C.

(Ex.: [0] [ENTER] [5] [0] [ENTER] [2] [5] [ENTER] [1] [ENTER] [1] [2] [ENTER] [2] [2] [ENTER] [3] [2] [ENTER] [4] [2] [ENTER])

With the above operation, 0.0 is entered for TIME, 50.0 for %B, 25.0 for %C, 1.000 for FLOW, and 12, 22, 32, 42 for EVENT. Up to 4 entries can be made per step for EVENT. Input an event to be executed within the set time. Refer to 3-9-7 for the event function.

```
TIME   %B    %C    FLOW    EVENT        [--]
_                                         1
```

A new input screen will appear, so enter time, mixing ratios for liquids B and C, flow rate and event.

(Ex.: [1] [0] [ENTER] [1] [0] [ENTER] [0] [ENTER] [1] [ENTER] [ENTER] [ENTER] [ENTER] [ENTER])

With the above operation, 10.0 is entered for TIME, 10.0 for %B, 0.0 for %C, and 1.000 for FLOW.

[ESCAPE]

(Monitor screen)

NOTICE:	A maximum of 99 steps can be entered for program Nos. 1 to 9.

NOTICE:	The entered program is saved. When power is turned on next time, the initial screen (TIME=0.0) of the program used just before power was turned off will appear.

3-8-4 Manual Operation

This section covers the manual operation of the high pressure gradient mode. This is used for liquid delivery under constant conditions without using a program. An example is given where liquid B is 10%, liquid C is 0%, flow rate is 1 mL/min, upper pressure limit is 41.2 MPa and lower pressure limit is 0 MPa.

Monitor screen

[MANUAL SET]

MANUAL:	%B	%C	FLOW	MAX	MIN	[MN]
	_0.0	0.0	0.000	41.2	0.0	

Input the solvent mixing ratios, flow rate, and the upper and lower limit pressure values.
(Ex.: [1] [0] [ENTER] [0] [ENTER] [1] [ENTER] [4] [1] [.] [2] [ENTER] [5] [ENTER])

Monitor screen

NOTICE:	The set conditions for manual operation will be erased when power is turned off. The conditions must be set each time power is turned on.

3-8-5 Analytical Operation

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

When the settings are all finished, carry out operation in the following procedure.

(1) Make sure the pump, column, detector and data processor are properly connected.

(2) Set the mobile phase and waste solution bottle in place.

(3) Start the pump and wait until the flow path is filled with the mobile phase.

(4) Warm up the pump, column and detector, and wait until the baseline stabilizes.

(5) Inject a sample.

(6) When analysis is finished, turn the power off and dispose of the waste solution.

NOTICE:	Before connecting a new column, make sure the flow path is filled with mobile phase so that air will not enter the column.

NOTICE:	The whirring sound of the pump during operation varies depending on such operating conditions as flow rate and pressure. Although the whirring sound may become larger anywhere in the high-pressure range, it is not a symptom of abnormality.

3-9 Utility

Utility functions such as zero adjustment of pump pressure, selection of pump pressure unit and column flushing are settable as follows.

3-9-1 Pressure Zero Adjustment

You do not need to perform a pressure zero adjustment every day. The zero point may change due to a secular change of the pressure sensor, etc. Check the pressure zero point once a month. If it has drifted, then stop the pump, open the drain valve and carry out the following operation.

Monitor screen

UTILITY
(SET UP)

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6> 1  FLUSH=4, EVENT=5, LINK=6
```

Select COND.(CONDITION SET).
[1] [ENTER]

```
CONDITION SET: Z-ADJ=1, M.CONTROL=2, [--]
<1-3>         1   L.P.GR.TYPE=3
```

Select Z-ADJ (PRESS ZERO ADJUST).
[1] [ENTER]

```
PRESS ZERO ADJUST: YES=1, NO=0       [--]
(OPEN DRAIN VALVE)  0
```

Open the drain valve, and then enter 1.
[1] [ENTER]

Monitor screen

PRESS indication becomes "0" and the pressure zero adjustment is finished.

3-9-2 Setting of Pump Motor Control Method

Automatic flow rate control method (STANDARD) and constant flow rate control method (FIX) are available as pump motor control methods.

Monitor screen

UTILITY (SET UP)

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6>  1 FLUSH=4, EVENT=5, LINK=6
```

Select COND.(CONDITION SET).
1 ENTER

```
CONDITION SET: Z-ADJ=1, M.CONTROL=2,[--]
<1-3>       1   L.P.GR.TYPE=3
```

Select M.CONTROL (MOTOR CONTROL).
2 ENTER

```
MOTOR CONTROL: STANDARD=1, FIX=2   [--]
<1-2>              1
```

1 ENTER → Monitor screen

MOTOR CONTROL is set to STANDARD.

2 ENTER →

```
FIX STEP AREA:                          [--]
 <30-300>     100
```

Input fix step area. Input is allowed within a range from 30 to 300.
(Ex: 1 0 0 ENTER)

Monitor screen

MOTOR CONTROL is set to FIX.

Refer to **section 3-8-2** for the usage of STANDARD and FIX and selection of FIX STEP AREA value.

3-9-3 Setting of Low Pressure Gradient Type

SLOW and FAST types are available for the low pressure gradient.

Monitor screen

[UTILITY (SET UP)]

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6>  1 FLUSH=4, EVENT=5, LINK=6
```

Select COND.(CONDITION SET).

[1] [ENTER]

```
CONDITION SET: Z-ADJ=1, M.CONTROL=2,   [--]
<1-3>        1    L.P.GR.TYPE=3
```

Select L.P.GR.TYPE (LOW PRESSURE GRADIENT TYPE).

[3] [ENTER]

```
L.P.GRADIENT TYPE: SLOW=1, FAST=2   [--]
                  1
```

[1] [ENTER] → Monitor screen

Low pressure gradient type is set to SLOW.

[2] [ENTER] → Monitor screen

Low pressure gradient type is set to FAST.

Refer to **section 3-7-2** for usage of SLOW and FAST types.

3-9-4 Setting of Pressure Unit

Pump pressure unit is selectable from bar, psi, kgf/cm^2 and MPa.

Monitor screen

UTILITY
(SET UP)

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6> 1  FLUSH=4, EVENT=5, LINK=6
```

Select UNIT.
[2] [ENTER]

```
PRESS UNIT: <bar=1, psi=2, kgf/cm2=3, [--]
<1-4>     1    MPa=4>
```

Select pressure unit.
(Ex.: [4] [ENTER])

Monitor screen

Pressure indication unit is set to selected one.

The set pressure unit is retained in memory even after turning off power supply. The relationship among selectable pressure units is listed below.

bar	psi	kgf/cm^2	MPa
10.0	145	10.2	1.00

3-9-5 Data Printout onto Model D-7500

Gradient program, gradient curve and logbook of the Model L-7100 can be printed onto the Model D-7500. For the printout, set D-line of L-7100 at ON and SYSTEM of D-7500 at DIGITAL.

Monitor screen

UTILITY (SET UP)

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6> 1  FLUSH=4, EVENT=5, LINK=6
```

Select PRINT.
3 ENTER

```
PRINT:   PROGRAM=1, GR-CURVE=2,     [--]
<1-3> 1  LOGBOOK=3
```

1 ENTER

```
PRINT PROGRAM No.?              [--]
<1-9>            1
```

Input the number of the program to be printed. Program number is selectable from 1 to 9.
(Ex.: 1 ENTER)

Monitor screen

Program of entered No. will be printed on D-7500.

2 ENTER

```
PRINT GR-CURVE No.?             [--]
<1-9>              1
```

Input the number of the gradient curve to be printed. Gradient curve No. is selectable from 1 to 9.
(Ex.: 1 ENTER)

Monitor screen

Gradient curve of entered No. will be printed on D-7500.

3 ENTER

Monitor screen

Logbook data will be printed on the D-7500.

3-9-6 Setting of Column Flushing

Automatic pump stop and/or column flushing after completion of analysis is settable. For connection with the Model D-7000 data station, set PUMP AUTO STOP to NO. All conditions will be set at the D-7000. By setting for column flushing, the flushing will be done automatically after the end of analysis. When a salt solution has been used for analysis, for example, elution of the salt component can be prevented by flushing the column with water. An example is given where the column is flushed for 30 minutes with 100% liquid C 15 minutes after the end of analysis.

Monitor screen

UTILITY (SET UP)

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6> 1  FLUSH=4, EVENT=5, LINK=6
```

Select FLUSH.
[4] [ENTER]

```
PUMP AUTO STOP: YES=1, NO=0          [--]
           0
```

Select YES (PUMP AUTO STOP).
[1] [ENTER]

```
COLUMN FLUSH: YES=1, NO=0            [--]
           0
```

[0] [ENTER]

```
SET DELAY TIME: TIME (min)           [--]
<1.0-600.0>     600.0
```

Input the time point of pump stop after completion of analysis.
(Ex.: [1] [5] [ENTER])

Monitor screen

[1] [ENTER]

```
SET DELAY TIME: TIME (min)           [--]
<1.0-600.0>     600.0
```

Input the time period from the end of analysis to the start of column flushing.
[1] [5] [ENTER]

```
COLUMN FLUSH: %B   %C   %D   FLOW      [--]
              100   0    0   1.000
```

Input column flushing conditions (mixing ratios of solvent B, solvent C and solvent D, and flow rate). The mixing ratio of liquid A is given by 100 - (%B + %C + %D). In the 2-liquid high pressure gradient mode, %C and %D are not displayed. In the 3-liquid high pressure gradient mode, %D is not displayed. In the high pressure gradient modes, the mixing ratio is displayed down to the first digit below decimal point.

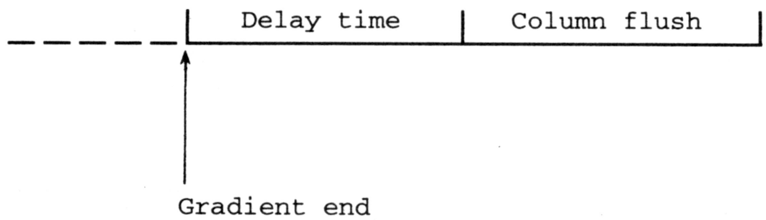
(Ex.: [0] [ENTER] [1] [0] [0] [ENTER] [0] [ENTER] [1] [ENTER])

```
FLUSHING TIME: TIME (min)             [--]
<1.0-600.0>     _30.0
```

Column flushing time can be input within 1.0 to 600.0 min.
(Ex.: [3] [0] [ENTER])

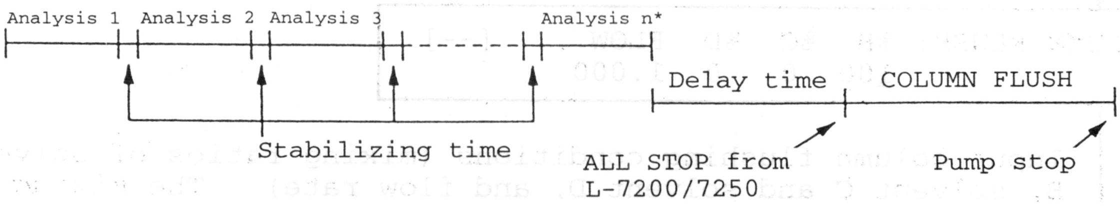
Monitor screen

Following is the relation between delay time and column flush.



(1) With AUTO STOP at YES

(a) When YES is selected for COLUMN FLUSH

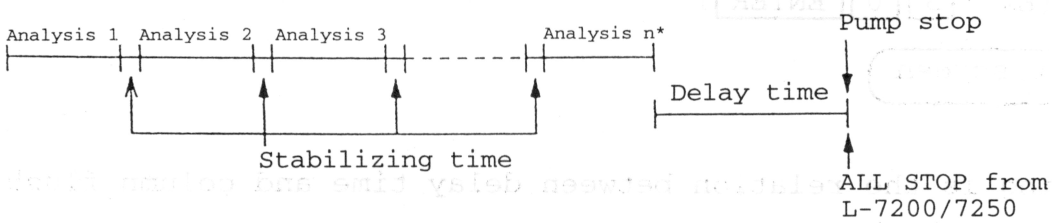


* "n" indicates number of analyses specified with autosampler, etc.

Stabilizing time is the time from the end of one analysis until the start of the next analysis. Column flushing starts when delay time has ended.

NOTICE:	If ALL STOP is received from the L-7200/7250 autosampler, column flushing starts even if the delay time has not yet ended.

(b) When NO is selected for COLUMN FLUSH

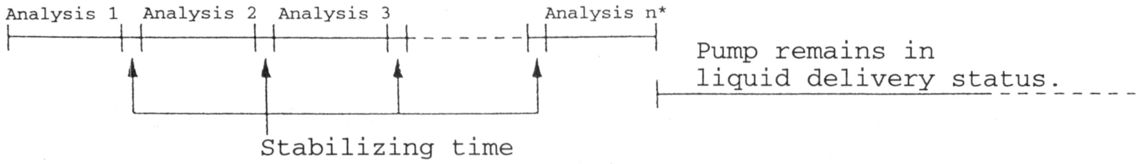


* "n" indicates number of analyses specified with autosampler, etc.

Stabilizing time is the time from the end of one analysis until the start of the next analysis. The pump stops when delay time has ended.

NOTICE:	If ALL STOP is received from the L-7200/7250 autosampler, the pump stops even if the delay time has not yet ended.

(2) With AUTO STOP at NO



* "n" indicates number of analyses specified with autosampler, etc.

The pump remains in liquid delivery status.

NOTICE:	The pump will not stop even if ALL STOP is received from L-7200/7250.

3-9-7 Setting of Event Code

The event should be executed manually. The event function works upon input of an event code. It is used for starting an external device, for stopping the pump, for sounding the buzzer, etc.

Monitor screen

↓ UTILITY (SET UP)

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6> 1  FLUSH=4, EVENT=5, LINK=6
```

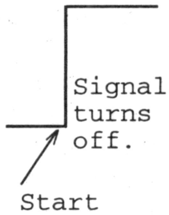
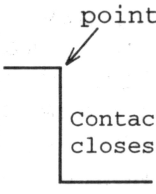
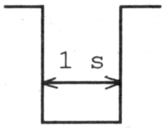
↓ Select EVENT.
[5] [ENTER]

```
SET EVENT CODE:                       [--]
<0-92>          _
```

↓ Input event code.
(Ex.: [0] [0] [ENTER])

Monitor screen

Event codes and related operations are explained below.

Control Item		Event Code			Remarks
Timer	1	10	11	12	1st digit: Timer no. 2nd digit: Action pattern
	2	20	21	22	
	3	30	31	32	
	4	40	41	42	
	Action	Contact opens.  Signal turns off. Start point	Start point  Contact closes. Signal turns on.	Open  1 s Close marker *	* Contact closes for 1 sec.
Pump		00			Pump stops
Buzzer		92			Buzzer sounds for 5 sec

3-9-8 Link Program Function

Multiple programs can be linked. For connection with the Model D-7000 data station, NO setting is required. All conditions will be set at the D-7000.

(1) Setting of Link Program

The method of setting a link program is explained next. An example is given where program No. 1 is executed once at the 1st step, a conditioning time of 30 minutes is allowed, then program No. 2 is executed three times at the 2nd step, after which a conditioning time of 20 minutes is allowed.

Monitor screen

UTILITY (SET UP)

```
UTILITY: COND.=1, UNIT=2, PRINT=3,   [--]
<1-6> 1  FLUSH=4, EVENT=5, LINK=6
```

Select LINK (LINK PROGRAM).

[6] [ENTER]

```
LINK PROGRAM:    YES=1, NO=0        [--]
                   0
```

Select YES.

[1] [ENTER]

```
LINK RESTART:      YES=1, NO=0       [--]
                     0
```

[1] [ENTER] → Monitor screen

After executing several steps of the link program, return is made to the 1st step without executing subsequent steps and the link program is executed. (For example, when a link program of 5 steps has been set, and link restart is executed after finishing 2 steps, the system returns to the 1st step instead of the 3rd step for executing the program.) And when multiple repetitions of the same step has been set, the system returns to the 1st step of the link program even if the set number of cycles has not yet ended. Settings must be made while the pump is in initial status ([IN] appears at status indication at top right of LCD), and cannot be made during gradient execution nor conditioning.

$\boxed{0}$ $\boxed{\text{ENTER}}$

```
STEPS PROG-No. CYCLE COND.TIME         [--]
  1       1      1        0.0
```

Enter program No.(PROG-No.), number of repetitions (CYCLE), and conditioning time (COND.TIME).
(Ex.: $\boxed{1}$ $\boxed{\text{ENTER}}$ $\boxed{1}$ $\boxed{\text{ENTER}}$ $\boxed{3}$ $\boxed{0}$ $\boxed{\text{ENTER}}$)

```
STEPS PROG-No. CYCLE COND.TIME        [--]
 2        1      1        0.0
```

Next is condition setting for the 2nd step. Enter program No., number of repetitions and conditioning time.
(Ex.: $\boxed{2}$ $\boxed{\text{ENTER}}$ $\boxed{3}$ $\boxed{\text{ENTER}}$ $\boxed{2}$ $\boxed{0}$ $\boxed{\text{ENTER}}$)

Enter as many link conditions as there are steps to be executed. The maximum number of steps is 9.

$\boxed{\text{ESCAPE (LOCK OFF)}}$

Monitor screen

Following is an explanation of each item.

Item	Explanation
STEP	Execution step No. cannot be input. This number is incremented serially.
PROG-NO.	Inputs the number of the program to be linked. Input is allowed within a range from 1 to 9.
CYCLE	Inputs the number of program repetitions. Input is allowed within a range from 1 to 99.
COND.TIME	Inputs the conditioning time of execution step. Input is allowed within a range from 0.0 to 600.0 (min). During conditioning time, liquid is delivered under the initial condition of execution step (TIME=0.0). On input of the start signal after the conditioning time, program execution starts.

NOTICE: When repeating the same step (CYCLE setting is 2 or more), conditioning time setting becomes ineffective upon switchover from the previous cycle to the next one. For repeating analysis of the same step, column conditioning time will be required. Since the conditioning time affects the reproducibility of the retention time, make sure to allow a sufficient conditioning time.
In case conditioning time is necessary upon cycle switchover, a program for conditioning must be input at the end of the program specified for the relevant step.

(2) Action According to Link Program

Link program uses two or more programs consecutively.
Action according to link program is explained below.

① Program

PROGRAM No. = 1

PRESSURE VALUE : MAX 19.6 MIN 1.0 MPa

TIME (min)	%A	CONCENTRATION %B	%C	%D	FLOW (ml/min)	EVENT 1	2	3	4
0.0	10	90	0	0	1.000				
5.0	10	90	0	0					
10.0	20	80	0	0					
15.0	20	80	0	0					
20.0	10	90	0	0					

PROGRAM No. = 2

PRESSURE VALUE : MAX 19.6 MIN 1.0 MPa

TIME (min)	%A	CONCENTRATION %B	%C	%D	FLOW (ml/min)	EVENT 1	2	3	4
0.0	30	70	0	0	1.000				
5.0	40	60	0	0					
10.0	40	60	0	0					
15.0	30	70	0	0					

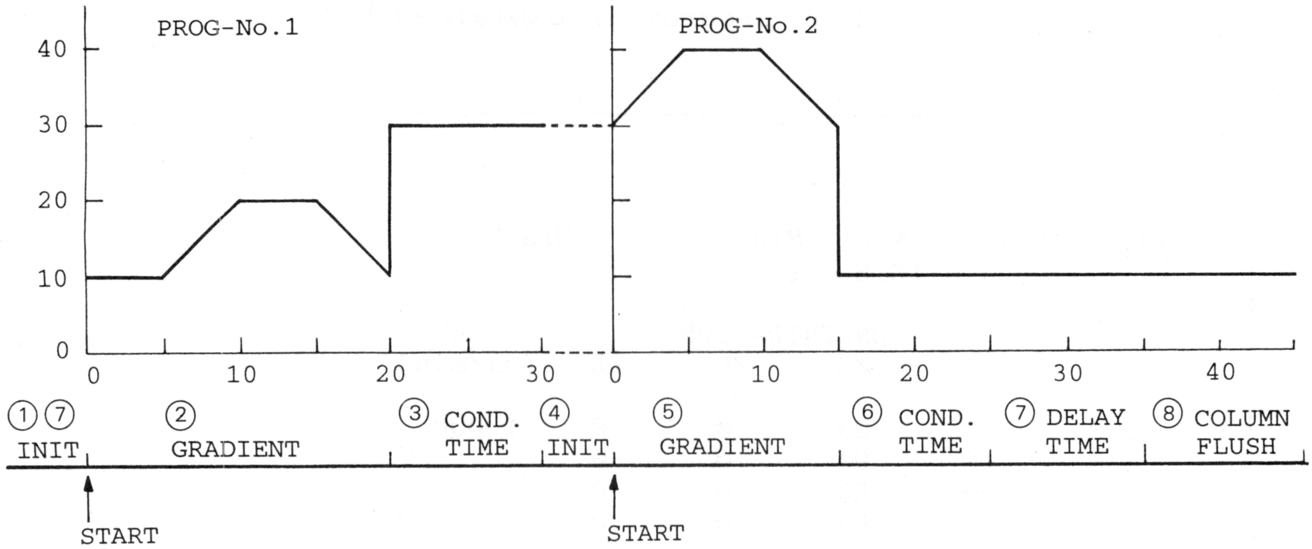
② Column flushing conditions

DELAY TIME	=	10.0	min
COLUMN FLUSH	=	YES	
A%	=	10	%
B%	=	90	%
C%	=	0	%
D%	=	0	%
FLOW	=	1.000	ml/min
TIME	=	10.0	min

③ Link program conditions

STEP	PROG-No.	CYCLE	COND. TIME(min)
1	1	1	10.0
2	2	1	10.0

(a) On Input of Start After Completion of Gradient Elution



Screen transition is explained for the above example. The encircled number matches between the example of execution and the screens shown below.

① Initial

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	10	90	0	0	1.000	5.5	1

Liquid is delivered in the initial status (under the initial conditions of program No. 1 in this example).

② Gradient

TIME	%A	%B	%C	%D	FLOW	PRESS	[GR]
10.0	20	80	0	0	1.000	5.5	1

Gradient elution is performed (according to program No. 1 in this example).

③ Conditioning time

TIME	%A	%B	%C	%D	FLOW	PRESS	[LC]
0.0	30	70	0	0	1.000	5.5	2

In conditioning time, liquid is delivered under the initial conditions for execution step (according to program No. 2 in this example). The pump status display in the conditioning time is [LC](LINK CONDITIONING TIME).

④ Initial

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	30	70	0	0	1.000	5.5	2

Liquid is delivered in the initial status (under the initial conditions of program No. 2 in this example).

⑤ Gradient

TIME	%A	%B	%C	%D	FLOW	PRESS	[GR]
5.0	40	60	0	0	1.000	5.5	2

Gradient elution is performed (according to program No.2 in this example).

⑥ Conditioning time

TIME	%A	%B	%C	%D	FLOW	PRESS	[LC]
0.0	10	90	0	0	1.000	5.5	1

In conditioning time, liquid is delivered under the initial conditions for execution step (according to program No. 1 in this example). The pump status display in the conditioning time is [LC](LINK CONDITIONING TIME).

⑦ Delay time (initial)

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	10	90	0	0	1.000	5.5	1

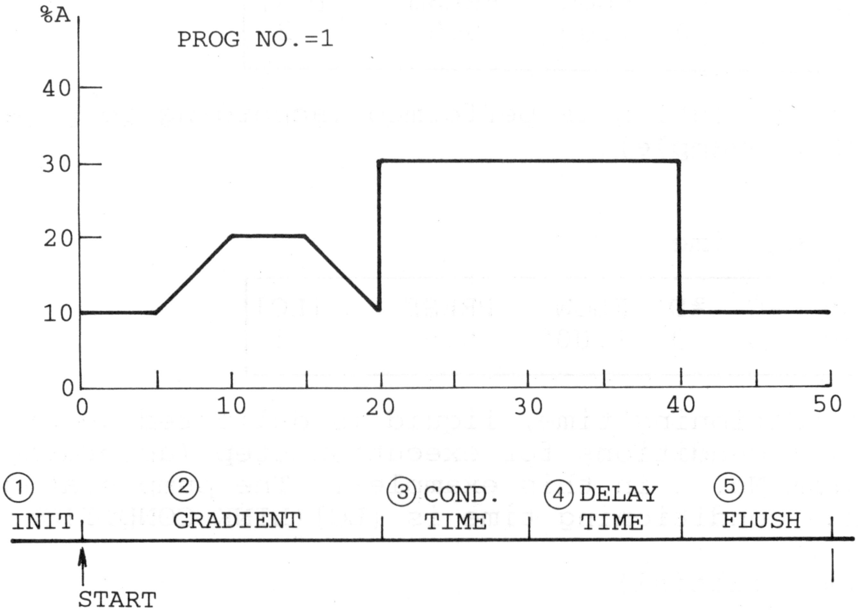
In case the start signal is not input in the initial status within the flushing delay time, column flushing will start. On input of the start signal within the delay time, the program for execution step will start.

⑧ Column flush

TIME	%A	%B	%C	%D	FLOW	PRESS	[FL]
0.0	10	90	0	0	1.000	5.5	1

Column flushing is carried out. Its conditions are settable in FLUSH of UTILITY.

(b) Without Start Input After Completion of Gradient Elution



Screen transition is explained for the above example. The encircled number matches between the example of execution and the screens shown below.

① Initial

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	10	90	0	0	1.000	5.5	1

Liquid is delivered in the initial status (under the initial conditions of program No. 1 in this example).

② Gradient

TIME	%A	%B	%C	%D	FLOW	PRESS	[GR]
10.0	20	80	0	0	1.000	5.5	1

Gradient elution is performed (according to program No. 1 in this example).

③ Conditioning time

TIME	%A	%B	%C	%D	FLOW	PRESS	[LC]
0.0	30	70	0	0	1.000	5.5	2

In conditioning time, liquid is delivered under the initial conditions for execution step (according to program No. 2 in this example). The pump status display in the conditioning time is [LC](LINK CONDITIONING TIME).

④ Delay time (initial)

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	30	70	0	0	1.000	5.5	2

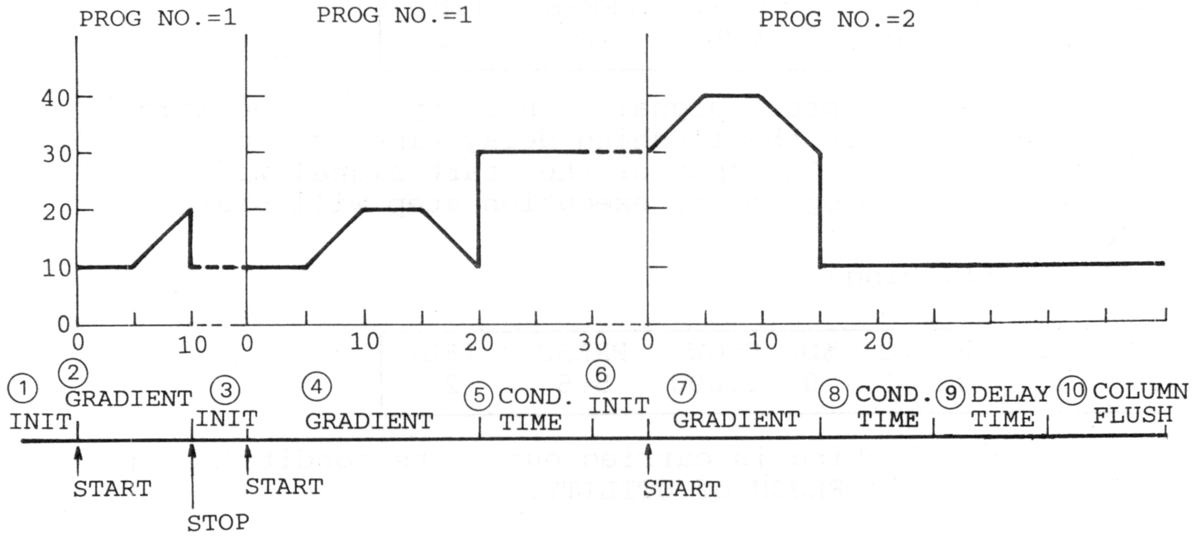
In case the start signal is not input in the initial status within the flushing delay time, column flushing will start. On input of the start signal within the delay time, the program for execution step will start.

⑤ Column flushing

TIME	%A	%B	%C	%D	FLOW	PRESS	[FL]
0.0	10	90	0	0	1.000	5.5	2

Column flushing is carried out. Its conditions are settable in FLUSH of UTILITY.

(c) At STOP During Execution of Gradient Elution



① Initial

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	10	90	0	0	1.000	5.5	1

Liquid is delivered in the initial status (under the initial conditions of program No. 1 in this example).

② Gradient

TIME	%A	%B	%C	%D	FLOW	PRESS	[GR]
10.0	20	80	0	0	1.000	5.5	1

Gradient elution is performed (according to program No. 1 in this example).

③ Initial

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	10	90	0	0	1.000	5.5	1

Liquid is delivered in the initial status (under the initial conditions of program No. 1 in this example).
If gradient elution is interrupted, the same step will be repeated.

④ Gradient

TIME	%A	%B	%C	%D	FLOW	PRESS	[GR]
10.0	20	80	0	0	1.000	5.5	1

Gradient elution is performed (according to program No. 1 in this example). In this case, the interrupted step will be executed.

⑤ Conditioning time

TIME	%A	%B	%C	%D	FLOW	PRESS	[LC]
0.0	30	70	0	0	1.000	5.5	2

In conditioning time, liquid is delivered under the initial conditions for execution step (according to program No. 2 in this example).

⑥ Initial

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	30	70	0	0	1.000	5.5	2

Liquid is delivered in the initial status (under the initial conditions of program No. 2 in this example). On input of the start signal in the initial status, the program for execution step (program No. 2 in this example) starts. In case the start signal is not input in the initial status within the flushing delay time, column flushing will start.

⑦ Gradient

TIME	%A	%B	%C	%D	FLOW	PRESS	[GR]
5.0	40	60	0	0	1.000	5.5	2

Gradient elution is performed (according to program No. 2 in this example).

⑧ Conditioning time

TIME	%A	%B	%C	%D	FLOW	PRESS	[LC]
0.0	10	90	0	0	1.000	5.5	1

After completion of the final step of link program, procedure returns to the first step of link program for conditioning (Program No. 1 in this example).

⑨ Delay time (initial)

TIME	%A	%B	%C	%D	FLOW	PRESS	[IN]
0.0	10	90	0	0	1.000	5.5	1

In case the start signal is not input in the initial status within the flushing delay time, clumn flushing wil start. On input of the start signal within the delay time, the program for execution step will start.

⑩ Column flushing

TIME	%A	%B	%C	%D	FLOW	PRESS	[FL]
0.0	10	90	0	0	1.000	5.5	1

Column flushing is carried out. Its conditions are settable in FLUSH of UTILITY.

3.10 Confidence

Explained here are the confidence functions such as logbook display and resetteng.

3.10.1 Logbook

Logbook can be displayed or reset.

(1) Logbook Display

Logbook can be displayed in the following procedure.

Monitor screen

CONFI-
DENCE

```
CONFIDENCE: LOGBOOK=1, PRESS M.=2,    [--]
<1-3>     1  KEY LOCK=3
```

Select LOGBOOK
1 ENTER

```
LOGBOOK: REPORT=1, RESET=2            [--]
<1-2>     1
```

Select REPORT for displaying logbook or RESET for resetting the logbook.

1 ENTER

```
LOGBOOK/REPORT                        [--]
        SOLVENT=99999 1 (2 25 94)
```

Total flow after replacement of the pump seal will be displayed.
Total flow after replacement of the pump seal will be displayed. Pump seal replacement date (month, day, year) is indicated in parentheses.

ESCAPE
(LOCK OFF)

Monitor screen

2 ENTER

```
LOGBOOK/RESET:                    [--]
(M, D, Y)          _2 25 94
```

Logbook is reset.

NOTICE:
Input the date of pump seal replacement. Input is allowed in the order of month (M), day (D) and year (Y).
Upon resetting, total flow value is reduced to 0 and the integration of flow starts. Unless the ENTER key is pressed after entry of all date values, resetting does not become effective.
Even when the year is the same as the displayed one, you should enter all values and then press the ENTER key.

Monitor screen

3-10-2 Pressure Monitor

The number of double-speed section errors in each measurement can be indicated.
A double-speed section error indicates that the pressure did not return to the reference level (previous pressure) even after double-speed control (an increase of pump motor speed) was effected to compensate for a pressure drop. This may be caused by formation of air bubbles in the flow path.

Monitor screen

[CONFIDENCE]

CONFIDENCE: LOGBOOK=1, PRESS M.=2, [--]
<1-3> 1 KEY LOCK=3

Select PRESS M.
[2] [ENTER]

PRESSURE MONITOR [--]
9999 TIMES

Display the number of double-speed section errors.

[ESCAPE (LOCK OFF)]

Monitor screen

Resetting occurs on the following occasions.

- On input of [PUMP ON] or [PUMP OFF]
- On activation of contact
- On start of gradient elution
- On reception of start signal from integrator in D-line configuration
- On external start of pump
- On input of [PURGE ON] or [PURGE OFF]

3-10-3 Key Lock

Keyboard keys can be locked.

Monitor screen

CONFI-
DENCE

CONFIDENCE: LOGBOOK=1, PRESS M.=2, [--]
<1-3>   1 KEY LOCK=3

Select KEY LOCK
3 ENTER

KEY LOCK: YES=1, NO=0
1

Locks the keys on the operation panel in order to prevent undesired key entries.
1 ENTER

Monitor screen

ESCAPE
(LOCK OFF)

Key lock can be released by the ESCAPE (LOCK OFF) key.

Monitor screen

3-11 Analysis Program

(1) SET PROGRAM allows the generation of a maximum of 9 programs. You can execute any of the programs selected or generated via the SET PROGRAM. For a gradient analysis, implement the following procedure.

1) Select [INIT], and select or generate a program for eluent.
2) Turn on each pump.
3) Start the program.

(2) Contents of SET PROGRAM

For the SET PROGRAM, enter the upper limit pressure level, lower limit pressure level, mixing ratio, flow rate, and event.

```
PROG NO.=1
     PRESSURE    MAIN  MAX  MIN  (MPa)
                       41.2  0
                         1)
                                              2)
    TIME    %A    %B    %C    %D    FLOW   EVENT
     0.0   100     0     0     0    1.000
    10.0    50    50     0     0    1.000   11 21 31 41
    10.1    40    60     0     0    1.000
    20.0    40    60     0     0    1.000
  3)25.0                                     10 20 30 40
    30.0     0   100     0     0    2.000
    30.1   100     0     0     0    1.000
    40.0   100     0     0     0    1.000    00 92
```

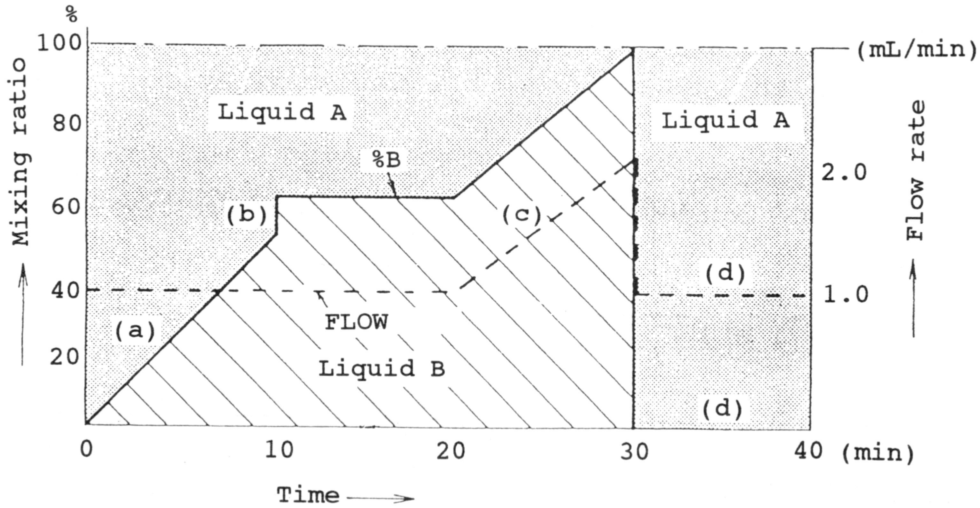
Fig. 3-4 Example of Program

1) The %D does not show in the three-liquid high pressure gradient mode. In the two-liquid high pressure gradient mode, the %C and %D do not show. The %A, %B, %C and %D do not show in the single-liquid delivery mode.

2) For EVENT, up to 4 event codes are settable at each time point. It is possible to generate contact outputs at each EVENT terminal at the same time. You can also obtain an internal action, such as a pump stop and the ringing of a buzzer.

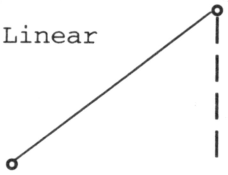
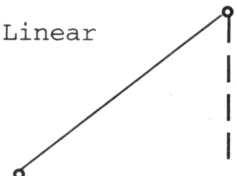
Example) EVENT=[1]-[1]-[ENTER]-[2]-[1]-[ENTER]

3) In case that an event setting is desired independent of %B, %C, %D, FLOW, etc., only the event code showed be entered. Press [ENTER] to skip all the entries you do not want until you reach event column.



(a) Linear gradient
(b) Stepwise gradient
(c) Flow rate program
(d) Conditioning for next analysis

In the SET PROGRAM mode, the interpolation of mixing ratio, flow rate, etc. that occurs in a time program is as follows.

Parameter	**Mixing Ratio**	**Flow Rate**
Interpolation	Linear  T_N T_{N+1}	Linear  T_N T_{N+1}

T_N, T_{N+1}: Preset time

> **NOTICE:** For generating a stepwise gradient program, utilize $T_{N+1} - T_N = 0.1$.

The program generating and modifying procedures are described in Sections 3-11-1 to 3-11-6. Each procedural flow is presented on the facing pages, i.e. the key operations are indicated on the left page and the relevant explanations are given on the right page. The numerals enclosed in circle on the left page corresponds to those on the right page.

3-11-1 New Generation of a Program

This section shows the generation of a new program.

① SET PROG ─ (SET PROG No.) ─ No. of program to be generated (m) ─ ENTER

② (MODIFY=0, NEW=1) ─ 1 ─ ENTER

③ (MAX) ─ Upper limit pressure level ─ ENTER

④ (MIN) ─ Lower limit pressure level ─ ENTER

⑤ (TIME) ─ Set time (Ti) ─ ENTER

⑥ (%B) ─ Set mixing ratio of liquid B (Bi) ─ ENTER

⑦ (%C) ─ Set mixing ratio of liquid C (Ci) ─ ENTER

⑧ (%D) ─ Set mixing ratio of liquid D (Di) ─ ENTER

⑨ (FLOW) ─ Set flow rate (Fi) ─ ENTER

⑩ (EVENT) ─ Event code (E1i) ─ ENTER

⑩ Event code (E2i) ─ ENTER

⑩ Event code (E3i) ─ ENTER

⑩ Event code (E4i) ─ ENTER

⑪ Repeat steps ⑤ to ⑩ until you define all programs lines.

⑫ To terminate the program generation press ESCAPE

① Program number can be from 1 to 9.

② When you want to define a new program, enter 1.
As a result, you will delete the previous program.
For modifying the contents of program, enter 0.

③ If pump pressure rises beyond the level set here, the pump automatically stops. The valid range is from 0.0 to 41.2 MPa (0 to 5976 psi).

④ If pump pressure falls below the level set here, the pump automatically stops. The valid range is from 0.0 to 41.2 MPa (0 to 5976 psi).

⑤ The set time can be from 0.0 to 600.0.

⑥ This display does not appear in the single-liquid delivery mode. Input is valid within 0 to 100 in the low pressure gradient mode and within 0.0 to 100.0 in the high pressure gradient mode.

⑦ This display does not appear in the single-liquid delivery mode and in the two-liquid high pressure gradient mode.
The mixing ratio can be within 0 to 100 in the low pressure gradient mode and within 0.0 to 100.0 in the high pressure gradient mode.

⑧ This display does not appear in the single-liquid delivery mode and in the high pressure gradient mode. The mixing ratio can be from 0 to 100. The mixing ratio of liquid A is determined by subtracting (total mixing ratio value of liquids B, C and D) from 100.
If a total value of %B, %C and %D exceeds 100%, its input cannot be accepted.

⑨ Flow rate valid entries are from 0.000 to 9.999.

⑩ Input the event code. At the set time point, you can stop the pump, generate an audible signal, markers, timers, etc.
When properly interfaced, these signals can be output to an external system. No display will show on the screen unless an event is set.
Refer to 3-9-7 for the event code function.

⑪ Repeat steps ⑤ to ⑩ until you complete the program and then press [ESCAPE].

⑫ Program generation will be terminated and the monitor screen will reappear.

For confirming the input conditions, check the parameters at each time point by using [▽] [Δ] keys.

3-11-2 Deletion of Program

How to delete a program is shown next.

① No. of program to be deleted (m)

SET PROG ─ (SET PROG No.) ─ No. of program to be deleted (m)

② 1 ③ ESCAPE

ENTER ─ (MODIFY=0, NEW=1) ─ 1 ─ ENTER ─ ESCAPE

3-11-3 Deletion of Step

How to delete one step in a program is shown next.

SET PROG ─ (SET PROG No.) ─

① No. of program containing step to be deleted (m) ─ ENTER ─ (MODIFY=0, NEW=1) ─

② 0 ─ ENTER ─ (MAX) ─ ③ Upper limit pressure level ─ ENTER ─ (MIN)

④ Lower limit pressure level ─ ENTER ─ ⑤ ∇ ─ ⑥ DELETE ─ ENTER ─ ⑦ ESCAPE

① Program number can be from 1 to 9.

② The contents of the existing program will be deleted.

③ The monitor screen reappears.

① Program number can be from 1 to 9.

② For editing, input 0. For generating a new program, input 1.

③ If pump pressure rises beyond the level set here, the pump automatically stops. The valid range is from 0.0 to 41.2 MPa (0 to 5976 psi).

④ If pump pressure falls below the level set here, the pump automatically stops. The valid range is from 0 to 41.2 MPa (0 to 5976 psi)

⑤ Press the $\boxed{\nabla}$ key until the step you want to delete appears on the screen. If display advances beyond that step, press the $\boxed{\Delta}$ key.

⑥ Press the $\boxed{\text{DELETE}}$ key when the cursor is on the TIME line want to delete.

⑦ To finish editing, press the $\boxed{\text{ESCAPE}}$ key. The display should then return to the monitor screen.

3-11-4 Addition of Step

① SET PROG — (SET PROG No.) — No. of program for adding a step (m) — ENTER —

② (MODIFY=0, NEW=1) — 0 — ENTER —

③ (MAX) — Upper limit pressure level — ENTER — ④ (MIN) — Lower limit pressure level — ENTER —

⑤ (TIME) — Time point of step added (Ti) — ENTER —

⑥ (%B) — Set mixing ratio of liquid B (Bi) — ENTER —

⑦ (%C) — Set mixing ratio of liquid C (Ci) — ENTER —

⑧ (%D) — Set mixing ratio of liquid D (Di) — ENTER —

⑨ (FLOW) — Set flow rate (Fi) — ENTER —

⑩ (EVENT) — Event code (E1i) — ENTER —

⑩ Event code (E2i) — ENTER —

⑩ Event code (E3i) — ENTER —

⑩ Event code (E4i) — ENTER —

① Program number can be from 1 to 9.

② For editing, input 0. For generating a new program, input 1.

③ If pump pressure rises beyond the level set here, the pump automatically stops. The valid range is from 0.0 to 41.2 MPa (0 to 5976 psi).

④ If pump pressure falls below the level set here, the pump automatically stops. The valid range is from 0 to 41.2 MPa (0 to 5976 psi).

⑤ Input the time point of the step you want to add.

⑥ This display does not appear in the single-liquid delivery mode. Input is valid within 0 to 100 in the low pressure gradient mode and within 0.0 to 100.0 in the high pressure gradient mode.

⑦ This display does not appear in the single-liquid delivery mode and in the two-liquid high pressure gradient mode. The mixing ratio can be within 0 to 100 in the low pressure gradient mode and within 0.0 to 100.0 in the high pressure gradient mode.

⑧ This display does not appear in the single-liquid delivery mode and in the high pressure gradient mode. The mixing ratio can be from 0 to 100. The mixing ratio of liquid A is determined by subtracting (total mixing ratio value of liquids B, C and D) from 100.
If a total value of %B, %C and %D exceeds 100%, its input cannot be accepted.

⑨ Flow rate valid entries are from 0.000 to 9.999.

⑩ Input the event code. At the set time point, you can stop the pump, generate an audible signal, markers, times, etc. When properly interfaced, these signals can be output to an external system. No display will show on the screen unless an event is set.
Refer to 3-9-7 for the event code function.

3-11-5 Correction of Step

Step correction method is explained here.

[SET PROG] ─ (SET PROG No.) ─

①
[No. of program containing step to be corrected (m)] ─ [ENTER] ─

②
(MODIFY=0, NEW=1) ─ [0] ─ [ENTER] ─

③ ④
(MAX) ─ [Upper limit pressure level] ─ [ENTER] ─ (MIN) ─ [Lower limit pressure level] ─ [ENTER] ─

⑤ ⑥
[∇] ─ (TIME) ─ [Time point of step added (Ti)] ─ [ENTER] ─

⑦
(%B) ─ [Set mixing ratio of liquid B (Bi)] ─ [ENTER] ─

⑧
(%C) ─ [Set mixing ratio of liquid C (Ci)] ─ [ENTER] ─

⑨
(%D) ─ [Set mixing ratio of liquid D (Di)] ─ [ENTER] ─

⑩
(FLOW) ─ [Set flow rate (Fi)] ─ [ENTER] ─

⑪
(EVENT) ─ [Event code (E1i)] ─ [ENTER] ─

⑪
[Event code (E2i)] ─ [ENTER] ─

⑪
[Event code (E3i)] ─ [ENTER] ─

⑪
[Event code (E4i)] ─ [ENTER] ─

① Program number can be from 1 to 9.

② For correction, input 0. For generating a new program, input 1.

③ If pump pressure rises beyond the level set here, the pump automatically stops. The valid range is from 0.0 to 41.2 MPa (0 to 5976 psi).

④ If pump pressure falls below the level set here, the pump automatically stops. The valid range is from 0.0 to 41.2 MPa (0 to 5976 psi).

⑤ Press the [∇] key until the step to be corrected appears on the screen. If the display advances beyond that step, press the [Δ] key.

⑥ When a correction is unnecessary, press the [ENTER] key only. The allowable input range is 0 to 9.999.

⑦ When a correction is unnecessary, press the [ENTER] key. This display does not appear in the single-liquid delivery mode. Valid mixing ratios are from 0 to 100 in the low pressure gradient mode and within 0.0 to 100.0 in the high pressure gradient mode.

⑧ When a correction is unnecessary, press the [ENTER] key. This display does not appear in the single-liquid delivery mode and in the two-liquid high pressure gradient mode. Valid mixing ratios are from 0 to 100 in the high pressure gradient mode.

⑨ When a correction is unnecessary, press the [ENTER] key only. No indication is given in the single-liquid delivery mode or the high pressure gradient mode. The allowable input range is from 0 to 100.
The mixing ratio of liquid A is determined by subtracting the total mixing ratio value of liquids B, C and D from 100.

⑩ When a correction is unnecessary, press the [ENTER] key. Valid flow is from 0.000 to 9.999.

⑪ Enter the event code. When a correction is unnecessary, press the [ENTER] key.
Refer to 3-9-7 for the event code function.

3-11-6 Deletion of Parameter

The parameter deletion method is shown next.

SET PROG —(SET PROG No.)—

①

No. of program containing parameter to be deleted (m) — ENTER —

②

(MODIFY=0, NEW=1)— 0 — ENTER —

③ ④

(MAX)— Upper limit pressure level — ENTER —(MIN)— Lower limit pressure level — ENTER —

⑤ ⑥ ⑦

∇ — ENTER — DELETE — ENTER

① Program number can be from 1 to 9.

② For correction, input 0. For generating program, input 1.

③ If pump pressure rises beyond the level set here, the pump automatically stops. The valid range is from 0.0 to 41.2 MPa (0 to 5976 psi).

④ If pump pressure falls below the level set here, the pump automatically stops. The valid range is from 0 to 41.2 MPa (0 to 5976 psi).

⑤ Press the $\boxed{\nabla}$ key until the step to be corrected appears on the screen. If display advances beyond that step, press the $\boxed{\Delta}$ key.

⑥ Move the cursor to the parameter to be deleted.

⑦ To delete the parameter, press the $\boxed{\text{DELETE}}$ key and then press $\boxed{\text{ENTER}}$ key.

3-12 Rear Panel

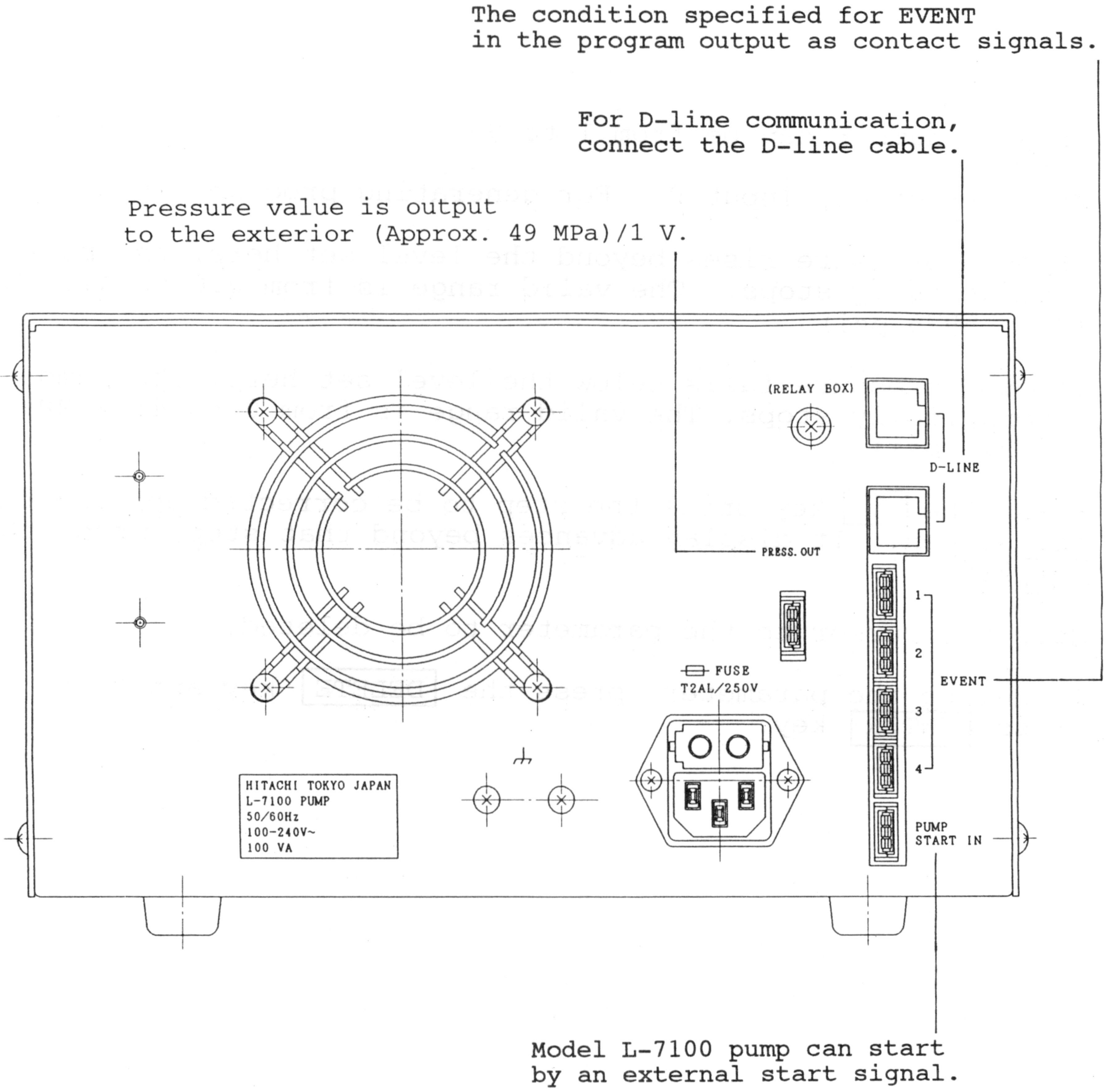


Fig. 3-5 Rear Panel of the Model L-7100 Pump

Table 3-3 Name and Function of Each Terminal at Rear Panel

<table>
<tr><th>Classi-
fication</th><th>Name</th><th>Function</th><th>Contents of Signal</th><th>Contents of Processing</th><th>Remarks</th></tr>
<tr><td>Output</td><td>TIMER
(1 to 4)</td><td>Contact turns on/off according to coded setting in EVENT of the program.</td><td>● Timer
ON:CLOSE
CLOSE
OFF:OPEN
OPEN

● Pulse
OPEN
1 s
CLOSE</td><td>The ON/OFF signal can output to each TIMER by specifying an ON/OFF EVENT code at a desired time of a time program.

1-second CLOSE signal can output at each TIMER by specifying pulse EVENT code at a desired time of a time program.</td><td>● TIMER No. and Event code
<table>
<tr><th rowspan="2">TIMER No.</th><th colspan="2">Signal</th><th rowspan="2">Pulse</th></tr>
<tr><th>OFF</th><th>ON</th></tr>
<tr><td>1</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>2</td><td>20</td><td>21</td><td>22</td></tr>
<tr><td>3</td><td>30</td><td>31</td><td>32</td></tr>
<tr><td>4</td><td>40</td><td>41</td><td>42</td></tr>
</table>
● Pump can be stopped by specifying 00 for EVENT, and buzzer can be rung by specifying 92.
1) Becomes OFF when the pulse is output in the ON status.
2) OFF has priority over ON.
3) Contact output specification of each terminal
Voltage ... 30 V DC max.
Current ... 100 mA max.</td></tr>
<tr><td></td><td>PRESS
OUT</td><td>Pressure value is output to the exterior</td><td>0 to 1 V DC</td><td></td><td>● 1 V = Approx.49 MPa
(Approx.7106 psi)</td></tr>
<tr><td>Input</td><td>PUMP
START IN</td><td>Pump ON from external system</td><td>OPEN *
50 ms
or longer</td><td></td><td>Maximum current connectable:10 mA
* Edge judgement</td></tr>
<tr><td>Others</td><td>D-LINE</td><td>Connector for D-line with D-7500, auto-sampler, and L-7400 detector.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>GROUND</td><td>Connect the shield terminal of the connection cord.</td><td></td><td></td><td></td></tr>
</table>

4. ANALYZING PROCEDURE

Table of Contents

4. ANALYZING PROCEDURE

This section explains the fundamental analyzing procedure. Before reading through this section, make sure the settings of the liquid chromatography system including the pump have been completed. Refer to **Section 2** for the settings of the system.

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

4-1 Before the Analysis

4-1-1 Precautions in the Selection and the Handling of the Mobile Phase

(1) Solvent Characteristics

Pay attention to the characteristics of the mobile phase and its temperature limitations. Refer to the organic solvent characteristics given in Table 4-2.

(2) High Sensitivity Analysis

Use solvents having a particularly low UV absorption when performing high sensitivity analysis, or when using a variable wavelength UV detector such as the L-7400.
Use HPLC grade solvents whenever possible. Be aware that methanol, ethanol, acetonitrile and other reagents give quite different absorbance characteristics at the low wavelengths. The differences depend on the production lot and on the manufacturer.

(3) Degassing

Perform degassing prior to utilizing a solvent. Follow the procedures outlined in section 4-2-2. Organic solvents have a particularly high air content. Air bubbles cause erratic operation of pump valves and degrade the column efficiency.

(4) Mobile Phase

Because the pump, column tubing, connecting tubes, and other wetted parts are made of stainless steel (SUS316), do not use solvents and reagents which corrode them. If you need to use them, perform the special procedures we recommend in this section to prevent corrosion. Particularly do not use solvents and solutions which contain halogen ions, such as solutions of HCl, KCl, NaCl and NH_4Cl. Reagents subjected to limitations are listed in Table 4-1.

NOTICE:	When using an undesirable reagent to effect a separation, rinse the entire system with distilled water after the analysis to prevent salt deposits and corrosion of the metal parts.

Table 4-1 Reagents Restricted for Mobile Phase

Usable	Usable below 50%	Usable below 10%	Undesirable for SUS316
Phosphoric acid Sodium phosphate	Acetic acid Ammonium citrate Ammonium acetate Citric acid Butyric acid Sodium nitrate	Disodium phosphate Ammonium formate Ammonium perchlorate Monobasic ammonium phosphate Boric acid Formic acid (up to pH3) Hydrochloric acid (up to pH3) Potassium nitrate Sodium bicarbonate Sodium carbonate	Ammonium chloride Potassium chloride Sodium chloride Trifluoroacetic acid **Notes:** 1. The maximum concentration of above reagents must be 5 to 6%. 2. After using the above reagents unavoidably, rinse the entire flow path with distilled water.

In addition to the above reagents, do not use reagents that would corrode stainless steel (SUS316). Also, note that the use of solvents having a high viscosity would hinder liquid delivery.

4-1-2 Organic Solvent Characteristics

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

Table 4-2 gives the characteristics of the organic solvents most commonly used in liquid chromatography.

Table 4-2 Organic Solvent Characteristics

	Polarity $E^2(Al_2O_3)$	Viscosity (cP20°C)	Refractive Index	Cut-off Wavelength in UV Region (nm)	Flash Point (°C)	Ignition Point (°C)	Ignition Point Lower Limit	Ignition Point Upper Limit	Vapor Density (air=1)	Boiling Point (°C)	Specific Gravity (Water=1)
Fluoroalkanes	−0.25		1.25								
n−Pentane	0.00	0.23	1.358	210	<−40	308.9	1.5	7.8	2.5	$\boxed{36.1}$	0.6
Hexane	0.00		1.375	210	−21.7	233.9	1.2	7.5	3.0	68.9	0.7
Isooctane	0.01		1.404	210							
Petroleum ether	0.01	0.3		210							
n−Decane	0.04	0.92	1.412		46.1	207.8	0.8	5.4	4.9	173.9	0.7
Cyclohexane	0.04	1.00	1.427	210	−20	260	1.3	8	2.9	81.7	0.8
Cyclopentane	0.05	0.47	1.406	210							
Diisobutylene	0.06		1.411	210							
i−Pentene	0.08		1.371		−17.8	272.8	1.5	8.7	2.4	$\boxed{30}$	0.7
Carbon disulfide	0.15	0.37	1.626	380	−30	100	1.3	44	2.6	$\boxed{46.1}$	1.3
Carbon tetrachloride	0.18	0.97	1.466	265							
Amyl chloride	0.26	0.43	1.413	225	12.8	343.3	1.6	8.6	3.7	106.1	0.9
Butyl chloride	0.26		1.436	220	−9.4	460	1.8	10.1	3.2		0.9
					o−17.2	463.9	1.0	6.0		144.4	
Xylene	0.26	0.62−0.81	~1.50	290	m−25	527.8	1.1	7.0	3.7	138.9	0.9
					p−25	528.9	1.1	7.0		138.3	
i−Propyl ether	0.28	0.37	1.368	220	−27.8	443.3	1.4	21	3.5	68.9	0.7
i−Propyl chloride	0.29	0.33	1.378	225	−32.2	593.3	2.8	10.7	2.7	$\boxed{35}$	0.9
Toluene	0.29	0.59	1.496	285	4.4	536.1	1.4	6.7	3.1	110.6	0.9
n−Propyl chloride	0.30	0.35	1.389	225	<−17.8		2.6	11.1	2.7	$\boxed{46.1}$	0.9
Chlorobenzene	0.30	0.80	1.525		32.2	637.8	1.3	7.1	3.9	132.2	1.1
Benzene	0.32	0.65	1.501	280	−11.1	562.2	1.4	7.1	2.8	80	0.9
Ethyl bromide	0.37		1.424			511.1	6.7	11.3	3.8	$\boxed{37.8}$	1.4
Ethyl ether	0.38	0.23	1.353	220	−45	180	1.9	48	2.6	$\boxed{35}$	0.7
Ethyl sulfide	0.38	0.45	1.442	290							
Chloroform	0.40	0.57	1.443	245							
Methylene chloride	0.42	0.44	1.424	245	−50	518.9	3.8	15.4	2.2	$\boxed{38.5}$	1.3
Methyl i−butyl ketone	0.43		1.394	330							
Tetrahydrofurane	0.45		1.408	220	−14.4	321.1	2	11.8	2.5	66.1	0.9
Ethylene dichloride	0.49	0.79	1.445	230	13.3	412.3	6.2	16	3.4	83.9	1.3
Methyl ethyl ketone	0.51		1.381	330	−6.1	515.6	1.8	10	2.5	80	0.8
i−Nitropropane	0.53		1.400	380	48.9	420.6	2.6		3.1	131.1	1.0
Acetone	0.56	0.32	1.359	220	−17.8	537.8	2.6	12.8	2.0	56.7	0.8
Dioxane	0.56	1.54	1.422	260	12.2	180	2.0	22	3.0	101.1	1.0
Ethyl acetate	0.58	0.45	1.370	260	4.4	460	1.8	8	3.5	90	0.9
Methyl acetate	0.60	0.37	1.362	210	−10	501.7	3.1	16	2.6	60	0.9
Amyl alcohol	0.61	4.1	1.410		32.8	300	1.2	10.0	3.0	137.8	0.8
Dimethyl sulfoxide	0.62	2.24									
Aniline	0.62	4.4	1.586		70	617.2	1.3		3.2	184.4	1.0
Dimethyl amine	0.63	0.38	1.387	275	<−17.8	312.2	1.8	10.1	2.5	56.7	0.7
Nitromethane	0.64	0.67	1.394	380	35	418.3	7.3		2.1	101.1	1.1
Acetonitrile	0.65	0.37	1.344	210	5.6				1.4	81.7	0.8
Pyridine	0.71	0.94	1.510	305	20		1.8	12.4	2.7	115	1.0
Butyl cellosolve	0.74			220							
i−Propanol n−Propanol	0.82	2.3	1.38	210	11.7	398.9	2.0	12	2.1	82.8	0.8
Ethanol	0.88	1.20	1.361	210	12.8	422.8	4.3	19	1.6	78.3	0.8
Methanol	0.95	0.60	1.329	210	11.1	463.9	7.3	36	1.1	63.9	0.8
Ethylene glycol	1.11	19.9	1.427	210	111.1	412.8	3.2			197.2	1.1
Acetic acid	Strong	1.26	1.372								
Water	Strong		1.333								
Salts & buffer	Stronger										

* L.R.Snyder, Dekker. "Principles of Adsorption Chromatography"

The enclosure (▭) indicates a solvent having too low a boiling point for use with the Model L-7100.

(1) Notice on Using Organic Solvent as Mobile Phase

(a) When using an organic solvent, pay attention to the ultraviolet wavelength cutoff.

The ultraviolet wavelength cutoff refers to a wavelength below which no light transmits. The wavelength cutoff for chloroform is 245 nm. This means that you should not use it at low wavelengths. For example, solvents containing chloroform cannot be used at 210 nm.

(b) Mobile Phase Boiling Point

You should not use mobile phases with very low boiling points in liquid chromatography. Use mobile phases with boiling points of 55°C or more. Mobile phases with lower boiling points are not only dangerous, but produce bubbles when the pump intakes the solvent. Bubbles affect the normal liquid supply and cause erratic flow and composition.

(c) For high-sensitivity analysis using a UV detector, use a solvent having a characteristic of minimum UV absorption. Note that such common special-grade reagents as methanol and acetonitrile provide rather high absorption at a short wavelength. It is advisable to use a reagent specifically manufactured for liquid chromatography.

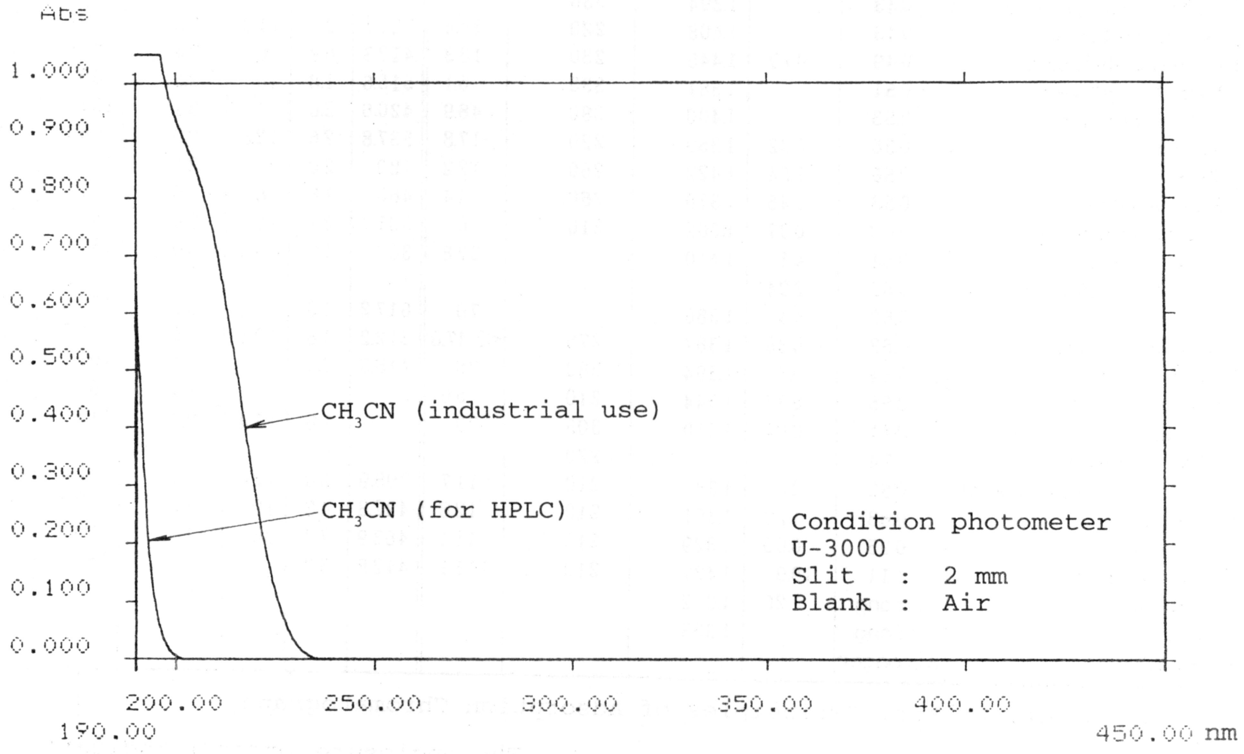


Fig. 4-1 Organic Solvent Absorption Spectrum

4-1-3 Static Electricity Cautions

> **⚠ WARNING**
>
> **Ignition of Flammable Chemicals via Static Electricity !**
>
> - Beware of ignition hazard when using flammable chemicals such as organic solvents.
> - Be careful about ignition due to static electricity when using flammable chemicals.
> - Observe the following points to prevent ignition due to static electricity.
>   - Use a grounded waste solution bottle made of an electrically conductive material so that static electricity will not accumulate.
>   - Do not bring flammable substances close to the system.

Since a high performance liquid chromatograph often uses flammable organic solvents, attention should be paid to the dangers of fire.

Small-diameter tubing, that is often used in a liquid chromatograph, generates static electricity. If the waste liquid collects in an insulated waste bottle, the waste solvent is often charged. If a discharge occurs and the solvent is flammable, the possibility of fire exists.

4-2 Preparation

NOTICE: For the usage of an ultrasonic cleaner, etc., refer to **their respective instruction manuals.**

4-2-1 Degassing and Filtering of the Mobile Phase

(1) Degas the mobile phase before use.

Oxygen, nitrogen, etc. present in the mobile phases will come out of solution and cause 1) degradation of mobile phase and sample, 2) lower column efficiency, 3) detector noise, 4) variation in pump pressure, and 5) lower accuracy of gradient mixing ratio.

(2) Use mobile phase free from small particles (dust).

If small particles enter the pump, they may clog the lines and interrupt the liquid flow. When a line plugs, the pressure will vary and cause flow control problems to occur.

4-2-2 Degassing of the Mobile Phase

There are several ways to degas solvents. Use the method that best suits your needs.

(1) Using the Degasser (e.g. Hitachi Model L-7610 Degasser)

(a) How to Attach the Inlet Tube

Use the inlet tube accompanying the pump or proportioning valve. Connect it with your hands instead of using a tool. When removing the tube from the proportioning valve, take care not to damage its threaded part.

(b) How to Attach the Connection Tube

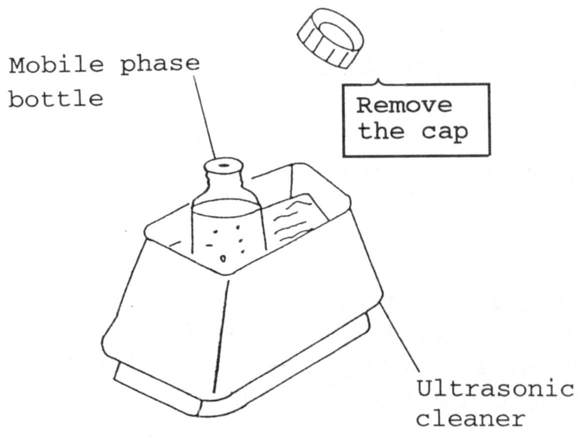
Connect the degasser with the pump or proportioning valve. Select a proper length of tube according to the degasser-pump arrangement. For connecting the tube, use your hands (do not use a tool). When attaching the tube to the proportioning valve, take care not to damage it.

(c) Suction of Mobile Phase

Aspirate mobile phase using the suction syringe furnished with the pump. Since the internal capacity of tube and degasser is about 7 mL, aspirate mobile phase repetitively. When multiple pumps are used, perform mobile phase suction for each pump. Also, when the proportioning valve is used, perform mobile phase suction for each valve flow path.

(d) Turn on the POWER Switch.

(e) For stabilization of the flow paths and substitution in them, start the pump to carry out online degassing. If the flow rate is too high, it may cause generation of air bubbles. To prevent this, set the flow rate at less than 5 mL/min.



NOTICE: Degassing the organic solvent mobile phase using an ultrasonic unit.

(2) Degassing by Using Ultrasonic Waves

(When the mobile phase is organic solvent)

Example:
100% methyl alcohol or a mixture of 80% methyl alcohol + 20% acetonitrile

Required instrument:
Ultrasonic cleaner (bath must be filled with water)

(a) Place the bottle filled with a well agitated mobile phase* into the ultrasonic cleaner that has been previously filled with water.

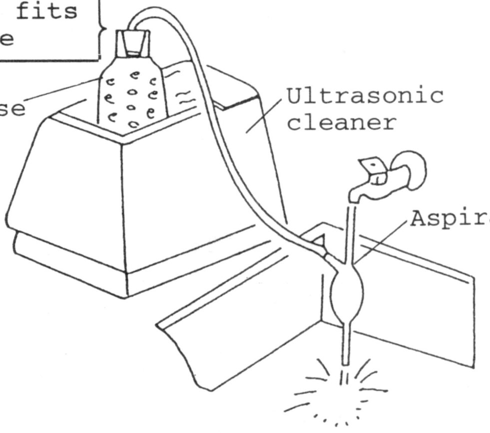
* When using a mixture of mobile phases, employ a magnetic stirrer to ensure that the solvents are well mixed. Otherwise, the analysis reproducibility will be poor and the baseline will drift.

(b) Turn on the ultrasonic cleaner.

(c) As degassing proceeds, small bubbles appear and they will grow gradually. Carry out this operation until bubbles no longer come out of the solution. This procedure will take about 5 to 10 minutes.

(d) Turn off the ultrasonic cleaner.

(e) Remove the solvent bottle from the ultrasonic cleaner, wipe the outside of the bottle and install it in the liquid chromatograph.



NOTICE: Degas the aqueous solution mobile phase by ultrasonic cleaner filled with water and by depression with aspirator. The degassing time must be constant.

(3) Example of Vacuum Degassing
(When mobile phase is aqueous solution)

For example:
20% methyl alcohol + 80% water, 0.2% citric acid aqueous solution.

Required instruments
1) Ultrasonic cleaner (bath must be filled with water)
2) An aspirator with a rubber plug of the correct size to match the bottle neck.

(a) Place a reagent bottle filled with a well mixed mobile phase* in the ultrasonic cleaner bath.

* When using a mixture of mobile phases, employ a magnetic stirrer to ensure that the solvents are well mixed. Otherwise, the analysis reproducibility will be poor and the baseline will drift.

(b) Place the rubber stopper and the tube coming from the aspirator in the reagent bottle.

(c) Turn on the ultrasonic cleaner.

(d) Slowly open the water tap that connects to the aspirator. This will reduce the pressure inside the

(e) As degassing proceeds, small bubbles appear and they gradually grow. Perform this operation until bubbles no longer come out of solution. It takes about 5 minutes for this operation.

NOTICE:
Bubbles come out differently depending upon the mobile phase composition. In case of a mobile phase mixed with an organic solvent (for example 20% methyl alcohol + 80% water), the mobile phase boiling point may vary under vacuum and therefore the mobile phase composition may change. To ensure analysis reproducibility, make sure the degassing time is constant.

(f) Before closing the water tap, remove the rubber tube from the aspirator that connects to the reagent bottle.

(g) Shut off the water tap after the rubber tube from the aspirator has been completely removed from the bottle.

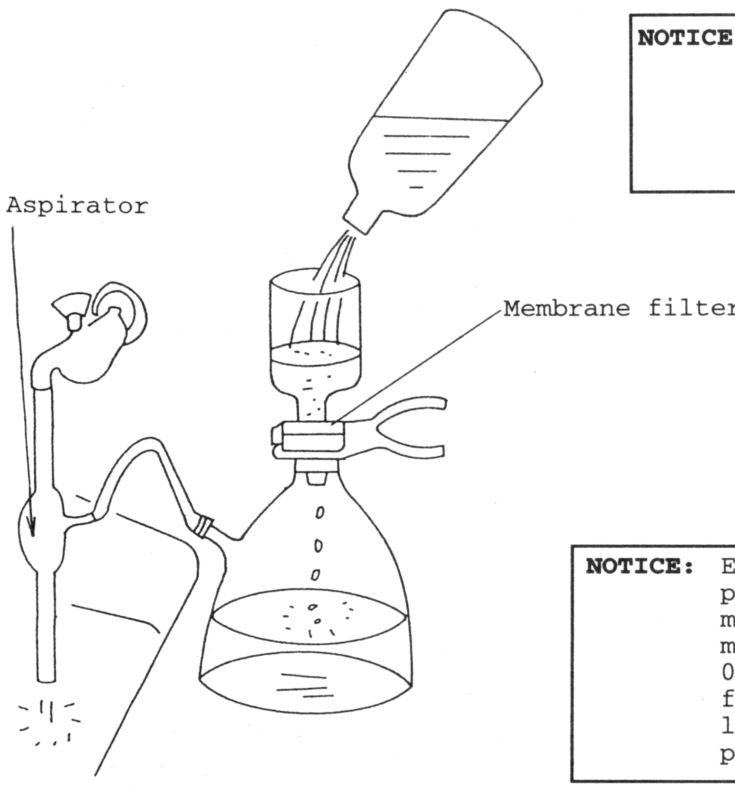
(h) Turn off the ultrasonic cleaner.

(i) Remove the mobile phase bottle from the ultrasonic cleaner, wipe off water from the outside of the bottle and install it in the liquid chromatograph.

4-2-3 Elimination of Small Particles from the Mobile Phase

Small particles (dust) left from the solvent purification steps are often in the solvents. You can eliminate these particles in many different ways. Select the method that best suits your needs.

(1) Filtering of Mobile Phase Using a Membrane Filter



NOTICE: Filtering through a membrane filter of 0.45 µm removes the small particles and performs degassing at the same time.

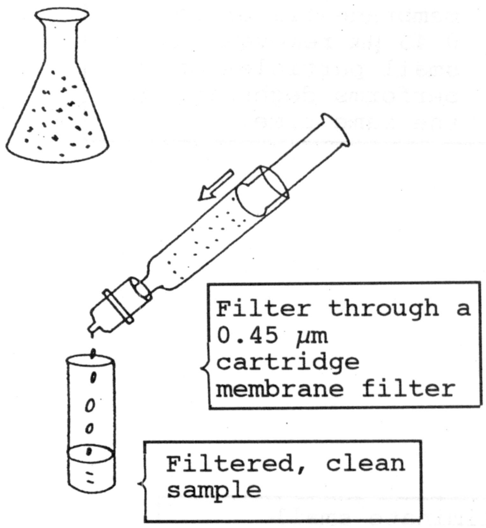
NOTICE: Eliminate small particles from the mobile phase using a membrance filter of 0.45 µm. (Do not use filter paper, because lint leaches from the paper.)

4-2-4 Sample Treatment

(1) Filter samples that contain fine particles. Otherwise, the particles may clog the injector. Particles in the samples may also cause the column to degrade prematurely.

(2) Eliminate foreign matter from the sample. Otherwise, abnormal peaks appear and data reliability will suffer.

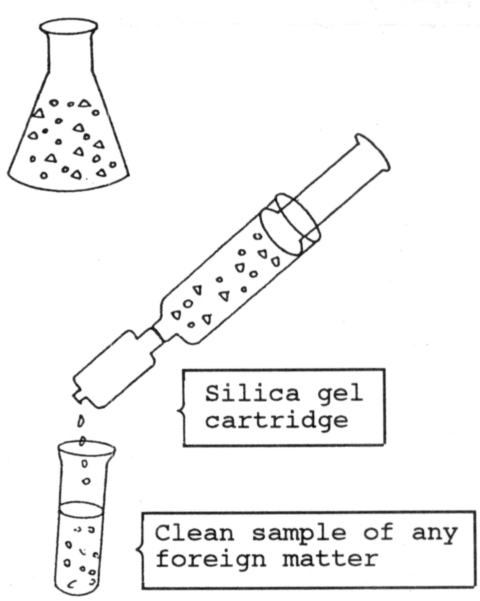
(a) Filtering of Sample



Mount a 0.45 μm cartridge membrane filter and perform filtering as shown in the illustration.

NOTICE: Small particles are retained by the membrane.
When filtering a sample, take into account the sample volume.

(b) Eliminating Foreign Matter from a Sample



For example, when analyzing a sample through a reverse phase column (i.e. ODS column), place the sample in a syringe and mount a normal phase cartridge as shown. When the sample passes through the cartridge, it will retain the foreign substances.

NOTICE: Foreign matter can be eliminated through several different ways. Choose the procedure that best suits your particular situation.

4-3 Analyzing Procedure

The following procedure is for analyzing a standard sample using a combination of the L-7100 Pump (in the manual single-liquid delivery mode), UV detector and D-7500 Integrator.

(1) Analyzing Conditions for the Standard Sample

Column	: ODS #3056 4 mm ID × 150 mm L
Mobile phase	: Methyl alcohol (special grade)
Flow rate	: 1.0 mL/min
Pressure	: 4.9 to 6.9 MPa (50 to 70 kgf/cm^2, 711 to 1001 psi)
Pressure limiter	
Upper limit	: 14.7 MPa (150 kgf/cm^2, 2133 psi)
Lower limit	: 0 MPa (0 kgf/cm^2, 0 psi)
Measuring wavelength	: 250 nm
Measurement range	: 0.256 AUFS
Data processing ATT	: 8
Chart speed	: 10 mm/min
Sample	: Standard sample (40 mg of naphthalene, 1.2 mg of anthracene and 1.5 mg of chrysene dissolved in 500 mL of methanol)
Sample injection volume	: 5 μL

(2) Required Articles

Column	: 1) ODS #3056 4 mm ID × 150 mm L 2) Lichrosorb RP-18 4 mm ID × 150 mm L 3) DuPont ODS 4.6 mm ID × 150 mm L **Note:** Any one of 1) to 3) is used
Methyl alcohol (special grade)	: 500 mL
Beaker	: 100 mL
Wrenches	: (M8, M14)
Microsyringe	: 10 μL, with square needle end
standard sample	

4-3-1 Turning on the Power

(1) Connect the power cord to the outlet.

⚠ WARNING
Ground Properly to Prevent Electric Shock Hazard! • Be sure to use the power cable supplied with the instrument. Use of a different power cable may result in an electric shock hazard. • This instrument is classified as "1" in IEC1010-1 Annex H and "plug-connected type" in IEC1010-1, so connect the power cable to a grounded 3-wire outlet. • If a grounded 3-wire outlet is not available, then be sure to provide proper grounding connection.

(2) Turn on the pump and the UV detector. After the D_2 lamp of the detector has come on, turn on the data processor.

4-3-2 Air Bleeding up to the Drain Valve (between the mobile phase bottle and the drain valve)

(1) Place the inlet tube and filter inside the mobile phase bottle.

(2) To open the drain valve knob, rotate it fully to the right side.

(3) Set the upper pressure limit to 14.7 MPa (150 kgf/ cm^2, 2134 psi) and the lower pressure limit to 0 MPa (0 kgf/ cm^2, 0 psi).

(4) Place a beaker under the drain tube.

(5) Press the PUMP ON/OFF key.

(6) Press the PURGE key. The pump starts operating. At this point, let the liquid flow until no bubbles come out of the drain pipe outlet (for about 1 to 2 minutes).

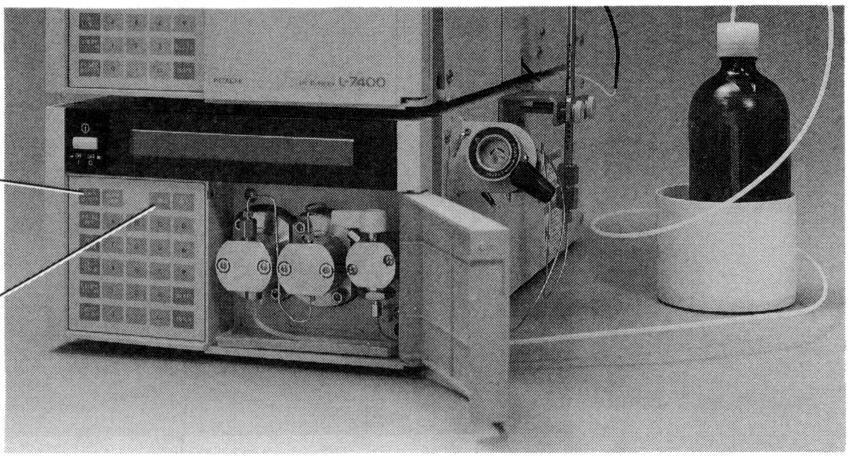
NOTICE:	Make sure the mobile phase bottle will not tip over.

(7) Press the PURGE key to cancel purging.

(8) Press the PUMP ON/OFF key to stop the pump.

PUMP ON/OFF key

PURGE key



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4-3-3 Air Bleeding up to the Column Connection Tube (between the drain valve and the column connection tube)

(1) Close the drain valve by turning it fully to the left side.

(2) Set the flow to 1 mL/min.

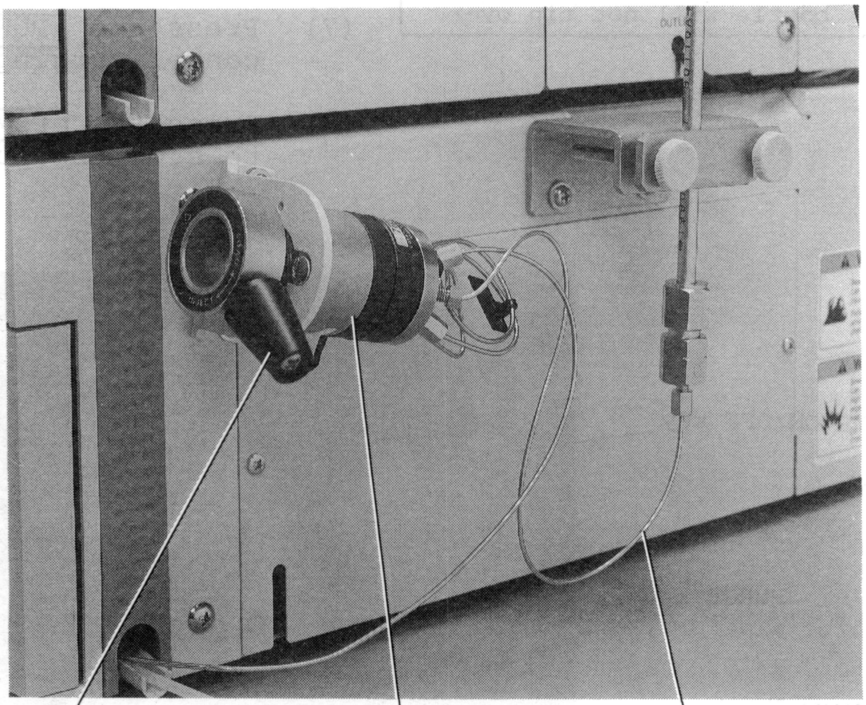
(3) Press the $\boxed{\text{PUMP ON/OFF}}$ key to start the pump.

(4) Confirm the liquid flows out of the column connection tube outlet.

(5) Change the injector valve between LOAD and INJECT several times. Finally, let the valve rest in the INJECT position.

(6) Press the $\boxed{\text{PUMP ON/OFF}}$ key to stop the pump.

(7) Set the lower pressure limit to 0.5 MPa (5 kgf/ cm^2, 71 psi).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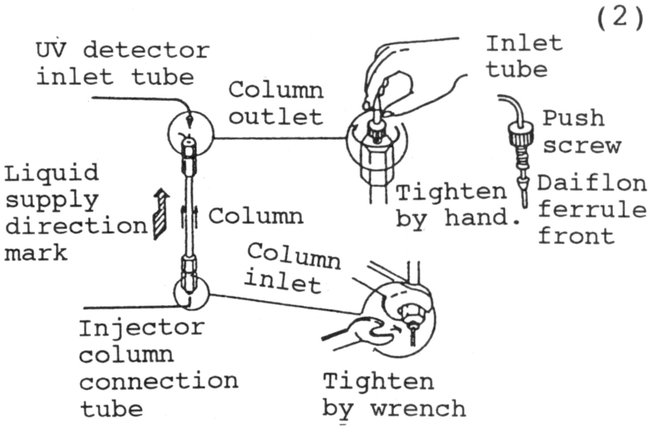
Injector knob

Injector

Column connection tube

4-3-4 Column Mounting Procedure



(1) Remove the plugs from the column inlet and outlet using a wrench.

(2) Connect the column connection tube to the column inlet.
Pay attention to the liquid flow direction.
Follow the column manufacture recommendations.

4-3-5 Connecting the UV Detector

(1) Press the $\boxed{\text{PUMP ON/OFF}}$ key to operate the pump.

(2) Confirm the liquid comes out of the column outlet. Connect the inlet tube from the UV detector to the column outlet. (Tighten each by hand.)

(3) Confirm that the liquid flows out of the drain tube.

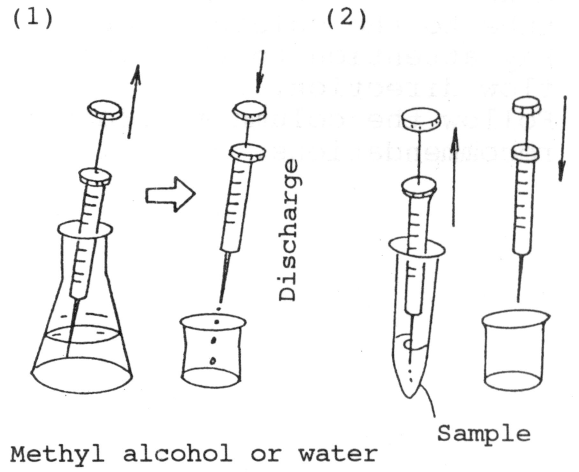
4-3-6 Checking and Setting the D-7500 Integrator

(1) Set detector output to 1 AUFS/1 V.

(2) Set the D-7500's attenuation (ATT) to 8 (0.256 AUFS) and the chart speed (C.S.) to 10 mm/min.
Refer to the instruction manual of the D-7500 for the setting procedure.

4-3-7 Sample Injection

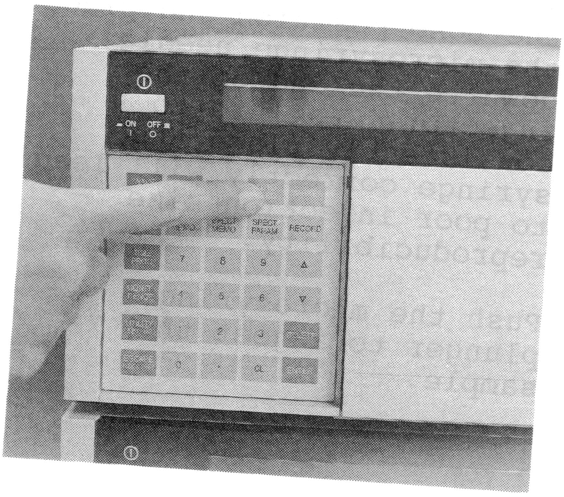
After the baseline of the data processor stabilizes, proceed with the analysis.



(1) Wash the microsyringe. Residual sample and contaminants sticking to the microsyringe will cause abnormal peaks, poor reproducibility, and other problems. Wash the syringe seven times or more. Use methyl alcohol when the mobile phase is an organic solvent. Use distilled water when the mobile phase is an aqueous solution. This washing procedure is extremely important when doing a high sensitivity analysis.

(2) Wash the microsyringe with the sample to be measured several times in order to eliminate errors due to a slight dilution caused by methyl alcohol, distilled water, or any other solvent inadvertently left in the syringe inner wall or the needle after washing the microsyringe. When not enough sample is available, dry the syringe prior to placing the sample into the syringe.

(3)



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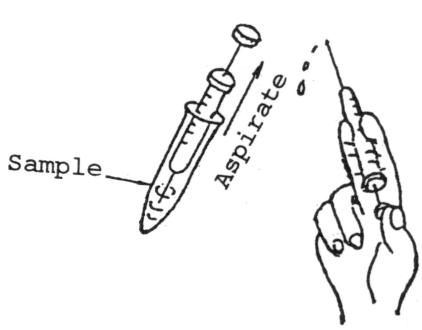
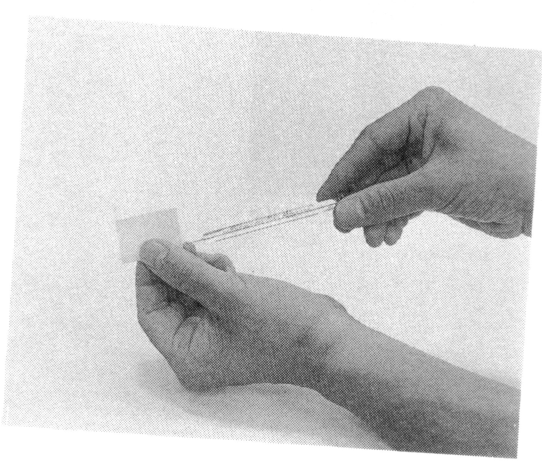
(3) Press the $\boxed{\text{AUTO ZERO}}$ key of the detector to zero it and to adjust the baseline at the data processor. When D-7500 Integrator is connected, press the $\boxed{\text{AUTO ZERO}}$ key of the detector and then the $\boxed{\text{TEST RUN}}$ key of the Integrator.

(4)



(4) Aspirate the sample into the microsyringe. To avoid measurement error, bubbles must never remain in the microsyringe. If bubbles are introduced, the syringe expels the sample. Draw in the sample again.

(5)



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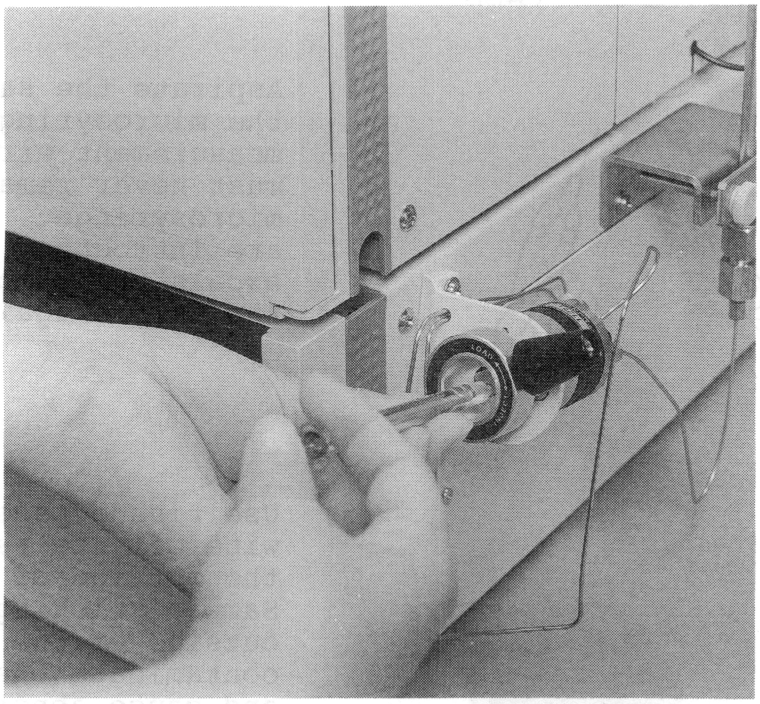
(5) Use tissue paper to quickly wipe off the sample from the outside of the needle. Sample sticking to the outside of the needle will contaminate the injector and cause abnormal peaks and poor reproducibility.

(6) (7)

(6) Rotate the injector knob to the LOAD position and place the microsyringe needle down to the end of the injector. Failure to consistently place the syringe correctly will lead to poor injection size reproducibility.

(7) Push the microsyringe plunger to inject the sample.



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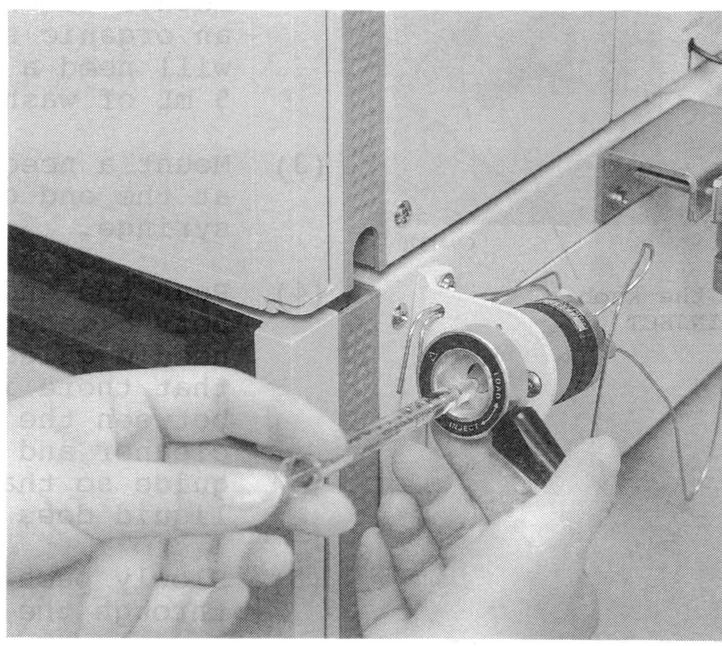
(8) (9)

(8) Quickly rotate the injector knob to the INJECT position.

(9) At the same time, press the START switch of the data processor. The analysis starts. Now, remove the syringe from the injector.

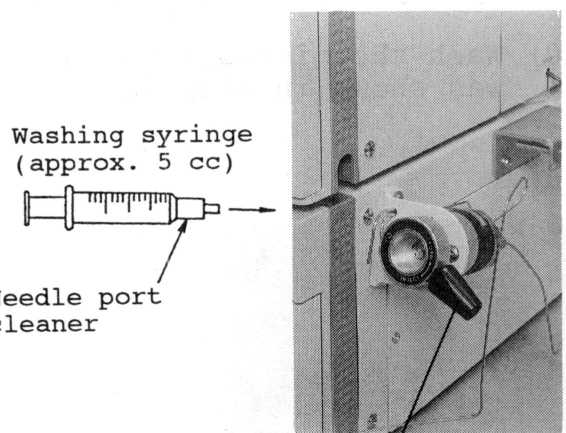
(10) Wash the microsyringe as was shown in step (1).



C941369

4-3-8 Washing the Injector

When analyzing a sample that contains a component in a high concentration, the injector may be left with traces of the sample. This contamination leads to poor reproducibility and/or ghost peaks in subsequent analysis. Wash the injector using the following procedure.



(1) Rotate the injector knob to be INJECT position.

(2) Place about 1 mL of a washing solution (distilled water in the case of water, methyl alcohol in case of an organic solvent). You will need a total of about 5 mL of washing solvent.

(3) Mount a needle port cleaner at the end of the washing syringe.

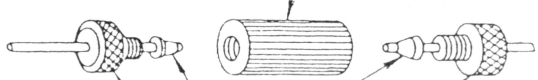
(4) Push the end of the needle port cleaner against the needle guide mouth. Ensure that there is a tight seal between the needle port cleaner and the needle guide so that the washing liquid does not leak.

(5) Slowly push the wash liquid through the injector.

4-3-9 Operations After an Analysis

(1) After an analysis, pump the mobile phase for about 15 minutes. Make sure all the injected sample components have left the column. If any component is present, the baseline will not stabilize.

(2) Turn off the D-7500 Integrator.



(3) Turn off the UV detector.

(4) Remove the column using the following procedure.

   (a) Set the flow rate to 0.2 mL/min.

   (b) Disconnect the inlet tube of the UV detector in the column outlet side and mount a plug by hand.

   (c) Remove the column connecting tube from the column inlet and mount a plug at the column inlet.

   (d) Press the $\boxed{\text{PUMP ON/OFF}}$ key to stop the pump.

   (e) Tighten the plugs on both ends of the column using a wrench.

   (f) Connect the UV detector inlet tube and drain tube with a jumper tube. By doing this, the flow cell will not dry, and you will avoid unstable baselines when using the detector in the next analysis.

(5) Turn off the pump power switch.

(6) Disconnect the power cords of all devices from their respective outlets.

NOTICE 1: When using saline solvent for mobile phase, salt may precipitate on the flow path to cause clogging or damage the valve seal parts. So, after using saline solvent, rinse the flow path thoroughly with distilled water.

NOTICE 2: When leaving the instrument stopped for a long time, remove injected sample completely from the flow path using solvent that can dissolve its components and then replace solvent with distilled water.

5. COLUMN PACKING METHOD

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5. COLUMN PACKING METHOD

Column is packed by the dry method, wet method, equilibrium slurry method, etc. For column packing, the Model L-7100 employs the wet method and equilibrium slurry method dependent on use of a packer. Into the column for Model L-7100, the packing material contained in the packer can be packed at the set pressure by activating the constant pressure mode subordinate to the single-liquid delivery mode.

5-1 Setting of Column Packing

For column packing, you should select the constant pressure mode subordinate to the single-liquid delivery mode.

(POWER ON)

↓ Self-diagnosis is performed.

```
TIME       FLOW       PRESS            [--]
 0.0       0.000       0.0              1
```

↓ MANUAL SET

```
MANUAL:    FLOW=1, PRESS=2             [MN]
<1-2>      1
```

↓ Select the constant pressure mode.

2 ENTER

```
CONSTANT PRESS:    PRESSURE            [MN]
                      _0.0
```

↓ Input a pressure value.

Pressure value can be input within 2.0 to 39.2 MPa.

Necessary packing pressure varies with packing material. So, input value should be determined in reference to the manual attached to each packing material.

(Ex.: 3 9 • 2 ENTER)

(Monitor screen)

5-2 Column Packing

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

Hitachi gel #3056 is selected here to exemplify column packing. For other packing materials, refer to the manual attached to each packing material.

5-2-1 Necessary Devices and Reagents

(a) Hitachi gel: #3056 (655-4021)

(b) Packer : For inner diameter 4 mm (885-0110)

(c) Column : 4.0 mm ID × 150 mm (885-3803)

(d) Balance (capable of measuring 10 g max.)

(e) Spatula

(f) Beaker (50 mL)

(g) Pipette (2 mL)

(h) Ultrasonic cleaner

(i) Tetrabromoethane

(j) Carbon tetrachloride

(k) Dioxane

(l) Methyl alcohol

(m) Wrench (inch system, M14 × 2, M21 × 2)

5-2-2 Packing Method

(1) Replace the inside of the pump flow path with methyl alcohol. When a buffer solution has been used, first replace with water in order to eliminate salts, and then with methyl alcohol.

(2) Remove the nipple from one end of the column (4 mm ID × 150 mm) and immerse the column in methyl alcohol.

(3) Connect the column to the packer.

(4) Connect the packer to the discharge port of pump and replace its inside with methyl alcohol.
Set the pump in the constant pressure mode subordinate to the single-liquid delivery mode and assign a pressure value of 34.3 MPa (350 kgf/cm^2).

(5) Measure 1.6 g of Hitachi gel #3056 and pour it into a beaker. Add and stir 10 mL of a slurred mixture of tetrabromoethane 40%, carbon tetrachloride 40%, dioxane 20% (V/V), and set the beaker to an ultrasonic cleaner for adequate dispersion.

(6) Inject the slurried packing material into the packer and close the lid promptly. Then, start liquid delivery by pressing the $\boxed{\text{PUMP ON/OFF}}$ key. (For liquid delivery, use methyl alcohol or methyl alcohol/H_2O = 80/20% (V).)
Before starting the pump, make sure that the pressure level is 0 Mpa.
When changing the setting, turn off the pump to make the pressure indication 0 Mpa. If the setting is changed without taking the above step, the pump control condition remains unchanged though the on-screen indication is changed.

(7) After liquid delivery for about 50 minutes, stop it by pressing the $\boxed{\text{PUMP ON/OFF}}$ key and wait until pressure falls to 0 MPa. Then, loosen the screw which connects the packer and column, and disconnect the column.

(8) Flatten the unevenness of the packing material at the leading end of column with a spatula or the like and attach the nipple which has been immersed in methyl alcohol.

(9) Seal both ends of column by using setscrews.

(10) The packing material remaining in the packer should be discharged by delivering liquid from the pump.

(11) Wash the remaining packing material with methyl alcohol, dry it naturally and store. The performance of the packing material will degrade as it is packed repeatedly. Therefore, the packing material after used repeatedly should be replaced with a new one.

6. PERFORMANCE CHECK

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6. PERFORMANCE CHECK

6-1 Checking the Mixing Ratio Accuracy in a Gradient System

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

6-1-1 Preparation Before Measurement

Before proceeding to performance check, be sure to remove air bubbles completely from the HPLC system flow path (the solvent filter in particular). For air purging, take the following procedure.

(1) Solvent : Methanol (guaranteed special grade)

(2) Flow rate : 9.999 mL/min

(3) Mixing ratio : A/B/C/D = 25/25/25/25 (%)

Under the above condition, perform air purging for at least five minutes (with the drain valve open).

NOTICE:

1. During low pressure gradient elution when the mobile phases are generated by mixing by the pump, the mobile phases may be unstable in their ratios at each step. This instability is the result of air bubbles in the flow path or contaminants adhering to the inner wall of the flow tube. Air bubbles remain in the solvent filters, proportioning valves or mixers in many situations. Flush the flow path using the following procedures to remove the air bubbles and contaminants and to ensure stability of the ratios at each step.

   (1) Using methanol solvent, purge the flow path for at least five minutes. Be sure to remove air bubbles completely from the flow path (the solvent filter in particular).

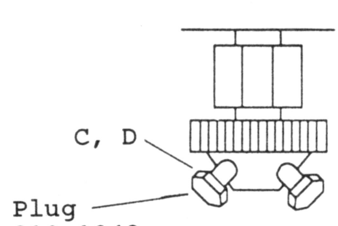
   (2) For air purging, use the degasser. Where the degasser is not equipped, deaerate the solvent thoroughly to prevent occurrence of air bubbles.

   (3) Open the drain valve and press [PURGE] key (set the purging at the maximum rate of 9.999 mL/min). To effectively purge each solvent path line, repeat this procedure for 3 to 5 minutes for solvents A, B, C and D.

   (4) Close the drain valve. This allows the flow of solvents A, B, C and D to pass through the detector. Then, flush the flow path with a mixed solvent that contains A solvent (25%), B solvent (25%), C solvent (25%), and D solvent (25%). Set the flow rate to 3 mL/min. Flush the lines for 15 minutes or more.

   (5) Press [INIT] key. This allows 100% of solvent to flow at a rate of 1 mL/min. Wait until the baseline stabilizes at the zero level. Then, start accuracy measurements of the gradient mixing ratio by pressing the [START STOP] key.

2. Using only mobile phases A and B, disconnect the tubes for channels C and D and attach plugs. When using only the mobile phases A, B and C, remove the D channel tube and attach the furnished plug to its port.



6-1-2 Conditions

(1) Measurement Conditions

Mobile phase A	: Distilled water
Mobile phase B	: 0.1% acetone aqueous solution
Column	: Connect a load resistance coil (0.25 mm ID × 10 m)
Detector	: Model L-7400 at 250 nm, 0.256 AUFS Time constant ... 2S Full scale ...... 1 AU/1 V
Degasser	: Model L-7610

> **NOTICE:** When checking the mixing ratio accuracy in a gradient system, be sure to degas using the degasser.

Low pressure gradient type	: Slow
Data processor	: Sampling period 800 ms

(2) Program Contents

(a) LOW PRESSURE GRADIENT

PRESSURE		MAIN : MAX			MIN (MPa)
		39.2			0
TIME	%A	%B	%C	%D	FLOW
0.0	100	0	0	0	1.000
0.1	90	10	0	0	
10.0	90	10	0	0	
10.1	50	50	0	0	
20.0	50	50	0	0	
20.1	10	90	0	0	
30.0	10	90	0	0	
30.1	0	100	0	0	
40.0	0	100	0	0	
40.1	100	0	0	0	

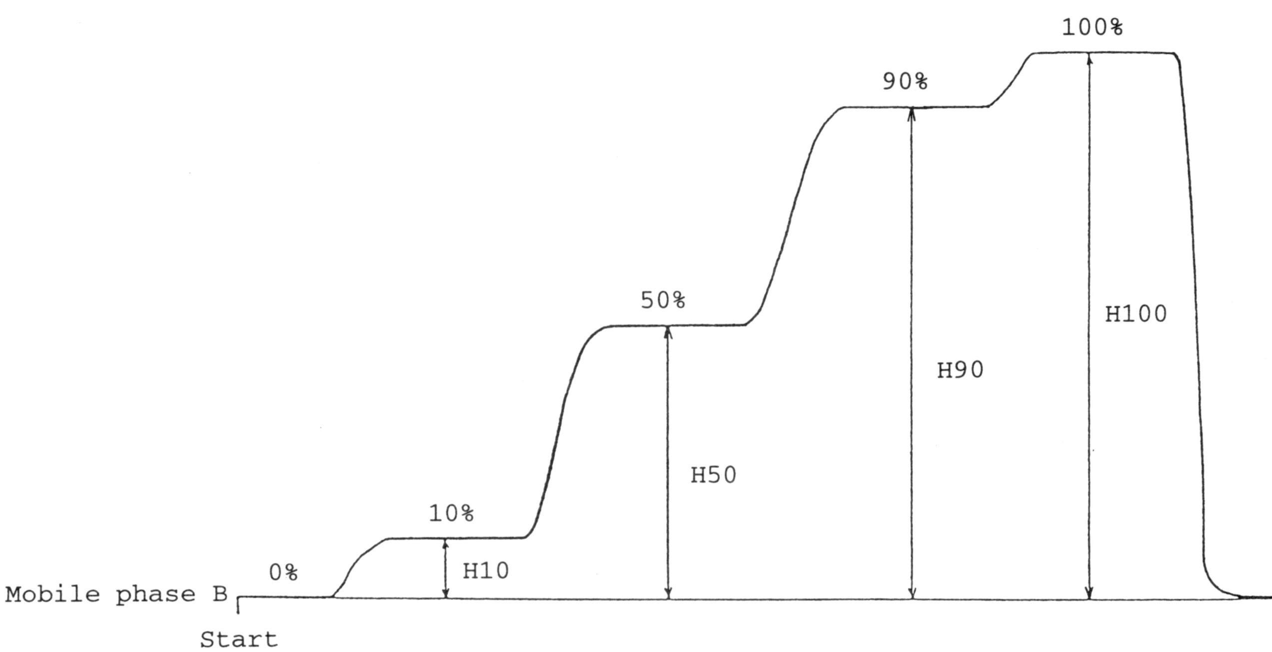
> **NOTICE:** Before checking the accuracy of gradient mixing ratio, be sure to observe the cautionary instructions in **2-2-2 (2) (mounting/tightening of each part)**.

(b) HIGH PRESSURE GRADIENT

PRESSURE		MAIN :	MAX	MIN (MPa)
			39.2	0
TIME	%A	%B		FLOW
0.0	100	0		1.000
0.1	90	10		
20.0	90	10		
20.1	50	50		
40.0	50	50		
40.1	10	90		
60.0	10	90		
60.1	0	100		
80.0	0	100		
80.1	100	0		

6-1-3 Mixing Ratio Calculation Method

Calculate the mixing ratio at 10, 50 and 90% with reference to 0 to 100%.



Mixing ratio:

$$B10 = \frac{H10}{H100} \times 100(\%)$$

$$B50 = \frac{H50}{H100} \times 100(\%)$$

$$B90 = \frac{H90}{H100} \times 100(\%)$$

6-1-4 Specifications

(1) Low Pressure Gradient Elution

Within ±1% when mixing ratio of mobile phase B is set to 10, 50 and 90%
(Example) B10 = 10 ± 1% = 9 to 11%

(2) High Pressure Gradient Elution

Within ±3% when mixing ratio of mobile phase B is set to 10, 50 and 90%
(Example) B10 = 10 ± 3% = 7 to 13%

7. MAINTENANCE AND INSPECTION

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7. MAINTENANCE AND INSPECTION

NOTICE: If the pump should become faulty, contact the dealer from whom you purchased the pump or your nearest Hitachi service agent. Repair must be left to personnel who have undergone Hitachi's technical training since potential hazards are involved.

7-1 Error Messages and Proper Measures

WARNING

Beware of Electric Shock !

Before removing the pump cover for parts replacement, etc., make sure to turn OFF the power switch and disconnect the power cord from the receptacle.

(1) If an abnormality occurs on the Model L-7100 pump, an error message appears on the LCD (Liquid Crystal Display). Error displays result from either the detection of a fault during the self-diagnostics at power up (upon initialization), or from a problem which occurs during operation.

Fig. 7-1 shows error detecting functions and the error messages.

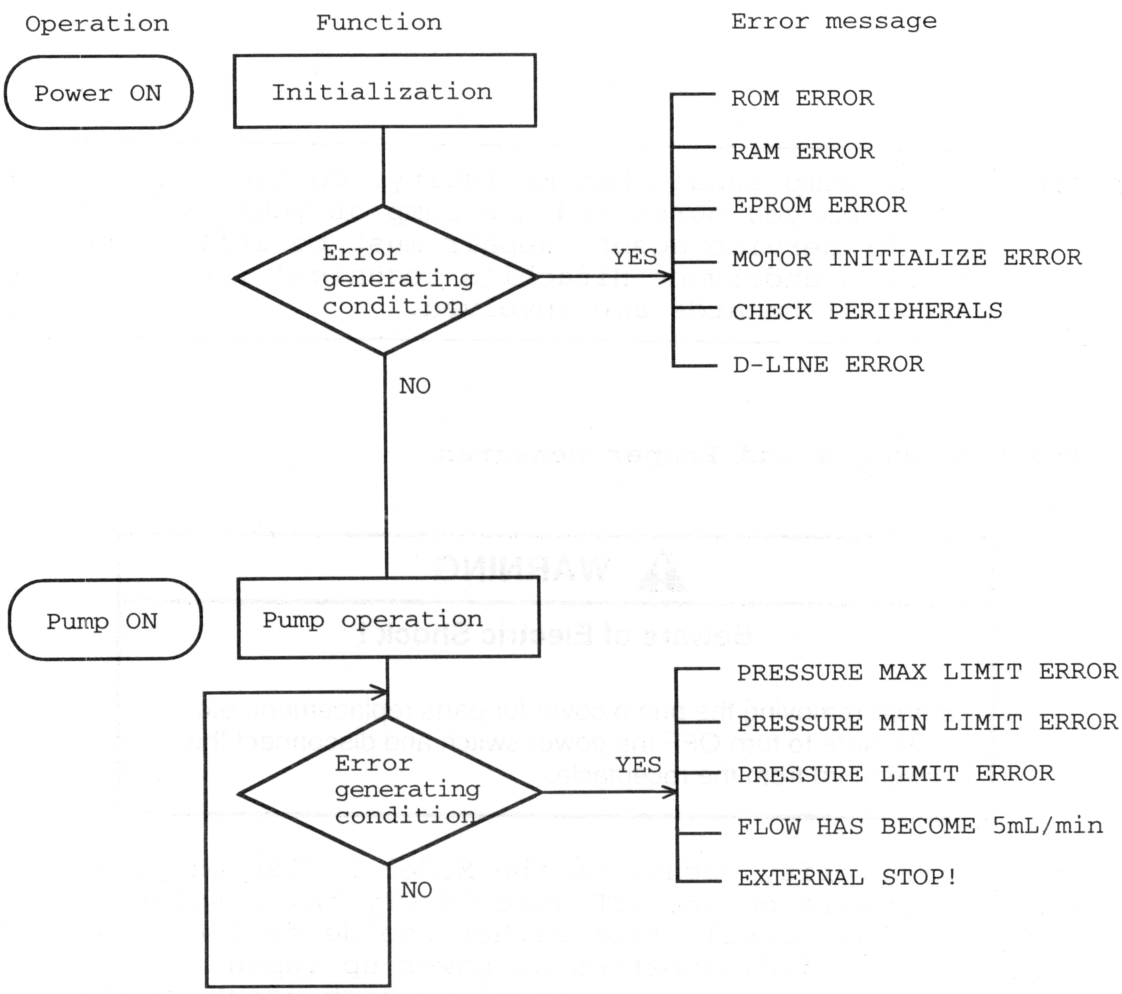


Fig. 7-1 Error Generation and Error Messages

(2) Each unit initializes immediately after its power is turned on. If a problem occurs, an error message displays in the LCD. If a problem develops during an analysis, an error message will also appear in the LCD. Use the $\boxed{\text{CL}}$ key to erase the error messages. Unless the cause of an error is eliminated, the same error message will display again. For units other than the Model L-7100, check the corresponding instruction manuals.

Table 7-1 Model L-7100 Error Messages

No.	Screen Display	Contents of Error	Measure
1	D-LINE ERROR	Error in communication via the D-line	This error can be cleared temporarily through the $\boxed{\text{CL}}$ key. Reconnection is not possible until you turn the power on in both the master and the slave stations.
2	ROM ERROR	Contents of ROM are abnormal.	Turn the power off and then on again. If the same error occurs, notify Hitachi service personnel.
3	RAM ERROR	The result of RAM check is abnormal.	Turn the power off and then on again. If the same error occurs, notify Hitachi service personnel.
4	EPROM ERROR	Contents of EPROM are abnormal.	Turn the power off and then on again. If the same error occurs, notify Hitachi service personnel.
5	PRESSURE MAX LIMIT ERROR	Upper pressure limit exceeded	Check the flow for leaks or clogging.
6	PRESSURE MIN LIMIT ERROR	Lower pressure limit exceeded	Check the flow for leaks or clogging.
7	PRESSURE LIMIT ERROR	On occurrence of PRESSURE MAX/MIN LIMIT ERROR in high pressure gradient operation, this error message is issued for other than the pump that has encountered the error.	Check the flow for leaks or clogging.

(cont'd)

No.	Screen Display	Contents of Error	Measure
8	MOTOR INITIALIZE ERROR	Motor rotation is abnormal.	Turn the power off and then on again. If the same error occurs, notify Hitachi service personnel.
9	CHECK PERIPHERALS	High-pressure slave pump is not connected.	Energize or reenergize the slave pump. If an error occurs during high pressure operation, the power of the master pump should be turned off and on again.
10	FLOW HAS BECOME 5 mL/min	Under constant pressure control, flow rate exceeds 5 mL/min.	Pump does not stop.
11	EXTERNAL STOP!	The pump is stopped by the emergency stop contact of D-line.	To clear the error message, press the CL key.

On occurrence of PRESSURE MAX/MIN LIMIT ERROR in the L-7100 pump, the pressure limit error signal is sent to the D-7000 so that it cannot recognize whether the upper or lower pressure limit has been exceeded.

7-2 Troubleshooting

Table 7-2 offers a guideline for the troubleshooting of the pump. Refer to this table first, if a problem occurs.

Table 7-2 Model L-7100 Troubleshooting

No.	Symptom	Cause	Measure
1	Input mode cannot be set by pressing SET PROG key.	The monitor screen is not in the programming mode.	Set the programming mode by pressing the INIT key.
2	Pump does not start when pressing the PUMP ON/OFF key.	Flow is set at 0.	Set the flow through the SET PROG of the MANUAL function.
3	Gradient delivery does not start when pressing the START/STOP key.	1) Display is other than the monitor screen. 2) The programming mode is not set.	1) Call the monitor screen by pressing the ESCAPE key. 2) Set the programming mode by pressing the INIT key.
4	Purging cannot be set or canceled by pressing the PURGE key.	Display is other than the monitor screen. Numerical input is awaited.	Call the monitor screen by pressing the ESCAPE key.
5	After appearance of the initialization screen when the power switch has been turned on, the D-line connection wait screen remains on the screen. The display does not change over to the monitor screen.	1) The D-line cable is not connected. 2) In the D-line configuration, the other unit connected is not energized.	1) Connect the D-line cable. 2) Turn on the D-line setting of the other unit.

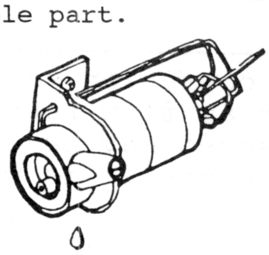
NOTICE: For troubleshooting of units other than the Model L-7100, for example, the Model D-7500, L-7400, etc., refer to **their manuals**.

NOTICE: The whirring sound of the pump during operation varies depending on such operating conditions as flow rate and pressure. Although the whirring sound may become larger anywhere in the high-pressure range, it is not a symptom of abnormality.

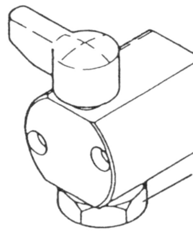
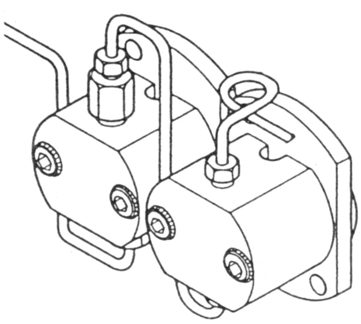
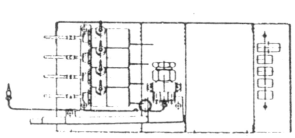
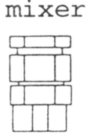
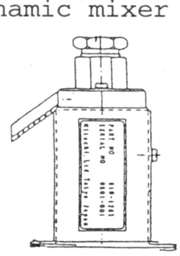
7-3 Period Maintenance and Inspection

Perform period maintenance and inspection according to Table 7-3. This prevents problems and ensures that your system meets specifications.

Table 7-3 Period Maintenance and Inspection

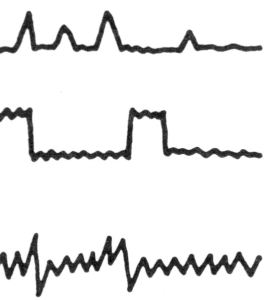
Check Location	Procedure	Remarks
1. Small particles (dust) are often present in the solvents.  Solvent filter	Wash the solvent filter with an ultrasonic cleaner every 4 months. Clean the solvent bottle every 2 days. Ensure that you are using the correct solvent when refilling the solvent bottle.	Intrusion of particles into the pump causes increase and/or unstable pressure and flow and composition problems will occur.
2. The column is expensive. 	1) Do not stop the pump just after completion of an analysis! The pump must be kept running for 30 minutes after completion of an analysis. 2) Do not introduce a sample containing particles! Ensure that the sample contains no particles or impurities. 3) Periodically clean the column! Components left in the column will contaminate it.	· Part of a complex sample is apt to remain in the column. This not only causes poor stability or drift, but shortens the column life. · Particles present in the sample plug the column filters. Pressure will increases abnormally. Impurities in the sample also contaminate the column. Impurities cause erroneous data. · Occasionally clean the column by injecting a large amount (1 to 3 mL) of solvent. The injection of the solvent will dissolve the sample residues. Cleaning of the column insures good separation and stability.
3. The seal in the sample injector is a consumable part. 	Be sure to replace the seal every year.	Abnormal wear of the seals causes leaks. Leaks result in poor data reproducibility.

(cont'd)

Check Location	Procedure	Remarks
4. The flow path filter is easily contaminated.  Flow path filter	Wash the filters with an ultrasonic cleaner every 4 months.	The filters prevent worn-out fragments of the pump seal from flowing into the column. If the filter is contaminated, the pressure increases abnormally.
5. The pump is the main component of a high speed liquid chromatograph. 	1) The pump seal is a consumable part! Be sure to replace the seals every 4 months (640 hours) 2) The high pressure pump must be kept clean! Clean the pump every month. For cleaning, just pass isopropanol through the pump for 30 minutes. 3) The high pressure pump does not function properly when there are bubbles. Before exchanging the solvent bottle or adding solvent into the bottle, be sure to turn off the pump.	· Deterioration of the seal causes leaks. Leaks lead to poor baseline stability and data reproducibility. The net result of leaks is degradation of reliability in measurement. · Contamination of the check valve, which is the critical part in a high pressure pump, causes pressure fluctuations, a failure in the pressure rise or easy adhesion of air bubbles. · Air bubbles in the pump cause pressure to fluctuate or fail to rise.
6. Proportioning valve 	When the instrument is to be left idle for a long time, fill the flow path with distilled water.	The solenoid valve can malfunction if crystals form inside the valve body.
7. Static mixer 	Wash the mixer in an ultrasonic cleaner every 4 months.	Collection of particles in the mixer causes air bubbles to form.
8. Dynamic mixer 	Inspect the mixer every 6 months. The stirrer must be replaced every 6 months.	Collection of dust particles in the mixer causes air bubbles to form.

intenance

Baseline Fluctuation, Noise, Drift

Trouble	Place to Check	Cause	Check Method	Result	Remedy
ne fluctuation, 	D_2 lamp W lamp	Deteriorated or worn out	First turn power supply off and wait about 10 minutes. Then turn the power on again, and if noise level is high as shown in the sketch at the left, it indicates the lamp is near the end of its life, though it is usable at low sensitivity. Next substitute the fluid in the cell and check the baseline. Are there abnormal peaks or abnormally high noise level? * Guaranteed lifetime of lamp: 1000 hr for D_2 lamp 1000 hr for W lamp	YES	Replace D_2 lamp Replace W lamp (See the detector instruction manual)
				NO	OK
	Cell	Contamination	Visually check for contamination in the cell. Is there contamination?	YES	Clean the cell (See the detector instruction namual)
				NO	OK
		Bubbles	Visually check for bubbles in the cell. Are there bubbles?	YES	Extract the bubbles (See the detector instruction namual)
				NO	OK

ne fluctuation,

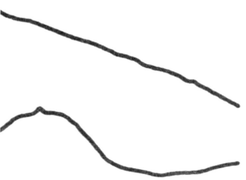
Liquid leakage from flow path

- Pump
  - Visually check for leakage from the pump. Is there leakage?
    * Lifetime of pump seal: 4 months
    - YES → Replace the pump seal (see 7-6-1)
    - NO → OK
- Flow path joint
  - Visually check for leakage from retaining screws. Is there leakage?
    - YES → Retighten retaining screws
    - NO → OK
- Detector
  - Visually check for leakage from the cell section. Is there leakage?
    - YES → Disassemble and clean the cell (see the detector instruction manual).
    - NO → OK

(cont'd)

Trouble	Place to Check	Cause	Check Method	Result	Remedy
e fluctuation, 	Pump Flow path	Valve, other part	Is there abnormal rise or fluctuation of pressure?	YES	See "Pressure Abnormality."
				NO	OK
	Drain tube	Inadequate inner diameter or length of drain tube	Is the specified tube connected?	YES	OK
				NO	Replace the drain tube with one of 0.33 mm ID × 2 m.
	Environment	Vibration			Should not be exposed to vibration from other equipment.

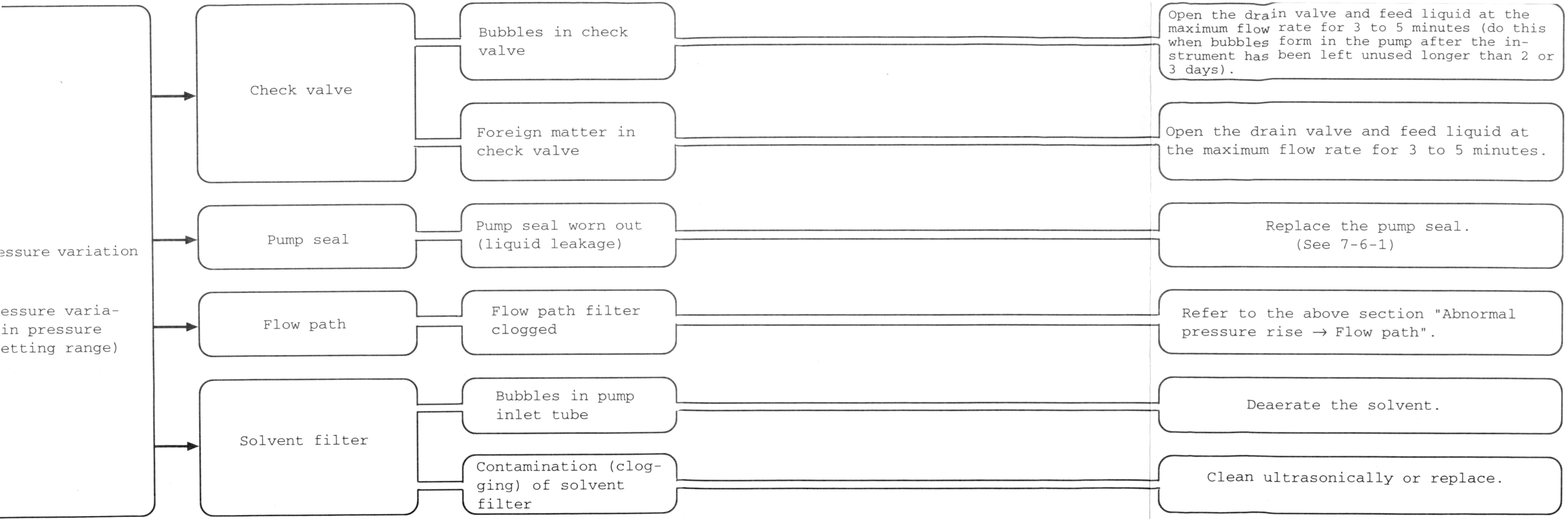
line drift



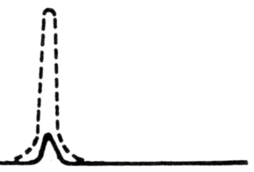
Liquid leakage from flow path	Pump		Refer to above section on liquid leakage from flow path.
	Flow path joint		
	Detector		
Substitution of fluid in flow path	Flow path (column)	Is fluid in flow path sufficiently substituted with solvent?	Sufficiently substitute solvent in flow path.
Environment	Change of room temperature		Maintain room temperature change within 5°C.
	Draft		Drafts should not directly reach column or detector.
Cell	Cell contamination		Refer to above section on cell.
D_2 lamp	Worn out or deteriorated		Refer to above section on D_2 lamp.
Column	Contaminated or deteriorated packing	Remove the column, connect the pump and detector and check the baseline. Is there drift?	YES — Replace the column.
			NO — OK
Column oven	Temperature unstable		Wait until temperature stabilizes.

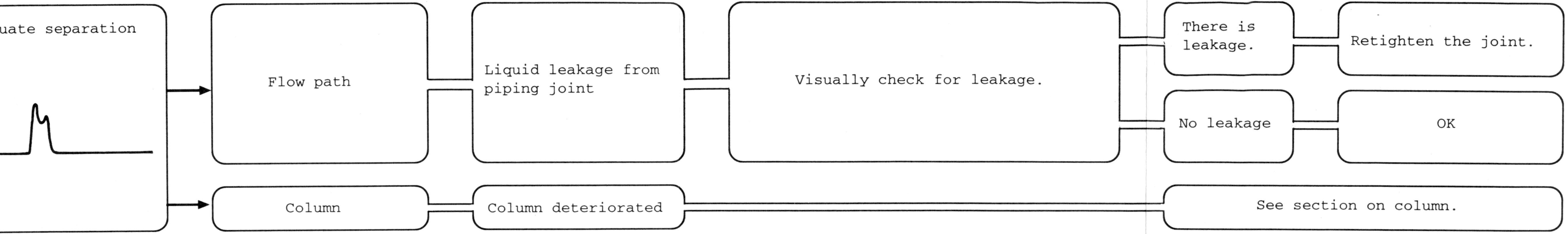
essure Abnormality

Trouble	Place to Check	Cause	Check Method	Result	Remedy
pressure rise	Column	Column filter clogged, or clogging due to contamination of packing	Feed liquid with the column removed. Is pressure almost zeroed?	YES	Replace the column.
				NO	OK
	Flow path	Flow path filter clogged	Remove the flow path filter and clean with an ultrasonic cleaner. Does pressure rise after this?	YES	Replace the flow path filter.
				NO	OK
		Clogged pipe between drain valve and column inlet	Remove pipes one at a time from column side to locate the faulty one.		(1) Mount the pipe reversely and operate the pump at a high flow rate to eliminate foreign matter. (2) Cut off the pipe from inside the ferrule and reuse. (3) After use of salty buffer solution, fill the flow path with distilled water.

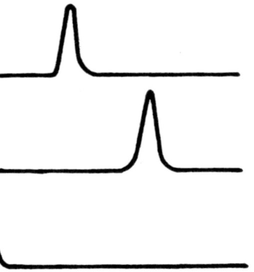

essure variation
essure varia-
in pressure
etting range)
Check valve
Bubbles in check valve
Open the drain valve and feed liquid at the maximum flow rate for 3 to 5 minutes (do this when bubbles form in the pump after the instrument has been left unused longer than 2 or 3 days).
Foreign matter in check valve
Open the drain valve and feed liquid at the maximum flow rate for 3 to 5 minutes.
Pump seal
Pump seal worn out (liquid leakage)
Replace the pump seal.
(See 7-6-1)
Flow path
Flow path filter clogged
Refer to the above section "Abnormal pressure rise → Flow path".
Solvent filter
Bubbles in pump inlet tube
Deaerate the solvent.
Contamination (clogging) of solvent filter
Clean ultrasonically or replace.

oor Sensitivity, Separation, Reproducibility

Trouble	Place to Check	Cause	Check Method	Result	Remedy
te sensitivity 	Autosampler	Joint piping	Visually check liquid leakage. Is there leakage?	YES	Retighten the joint.
				NO	OK
		Liquid leakage from injection port	Visually check for leakage.	There is leakage.	Retighten the joint. Replace injection port seal. (See the autosampler instruction manual)
				No leakage	OK
		Liquid leakage from syringe valve	Visually check for leakage.	There is leakage.	Replace the valve seal. (see the autosampler instruction manual)
				No leakage	OK
		Liquid leakage from injection valve	Visually check for leakage.	There is leakage.	Retighten the joint.
				No leakage	OK
		Liquid leakage from syringe	Visually check for leakage.	There is leakage.	Replace the syringe. (See the autosampler instruction manual)
				No leakage	OK
		Contamination of wash liquid and/or sample containers			Clean or replace the containers.
		Needle clogged			Clean the needle.
	Detector	Cell contamination, bubbles, leakage	Visually check the cell.		See section on cell in 7-4-1.


uate separation
Flow path
Liquid leakage from piping joint
Visually check for leakage.
There is leakage.
Retighten the joint.
No leakage
OK
Column
Column deteriorated
See section on column.

(cont'd)

Trouble	Place to Check	Cause	Check Method	Result	Remedy
roducibility of eak position 	Flow path	Liquid leakage from piping joint	Visually check for leakage.	There is leakage.	Retighten the joint.
				No leakage	OK
		Large pressure variation		Refer to "Pressure Abnormality" in 7-4-2.	
	Environment	Effect on the column		When column oven is not used, peaks will fluctuate with large change in room temperature.	
	Column oven	Temperature unstable		Wait until temperature stabilizes.	

eproducibility
ed peak area

Autosampler

Leakage from autosampler

Refer to section on autosampler above.

Flow path

Leakage from flow path

Visually check for leakage.

There is leakage.

Retighten the joints.

No leakage

OK

7-5 Gradient Mixer

In a gradient system, the gradient mixer is used for mixing multiple mobile phases.

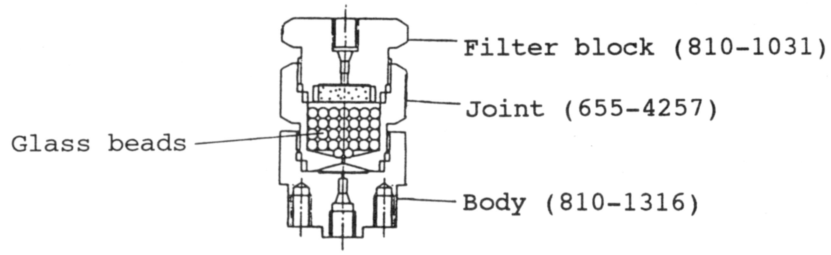
In a low pressure gradient system, the static mixer is used.
In a high pressure gradient system, the dynamic mixer is used.

7-5-1 Static Mixer

Used for low pressure gradient elution. When the flow rate exceeds 2.0 mL/min, it is recommended to use the dynamic mixer (option, P/N 810-1220). Refer to **section 3-7-2** for usage in the low pressure gradient mode.

(1) Structure of Static Mixer

The static mixer incorporates a single chamber containing glass beads.



(2) Maintenance

(a) Remove the filter block from the joint with a wrench.

(b) Take glass beads out of the joint and put them in a beaker (50 to 100 mL). Then, pour detergent (mobile phase used, etc.) into the beaker.

(c) Place the filter block and joint in another beaker, and inject detergent.

(d) Set the two beakers in an ultrasonic cleaner and clean them for 5 to 10 minutes.

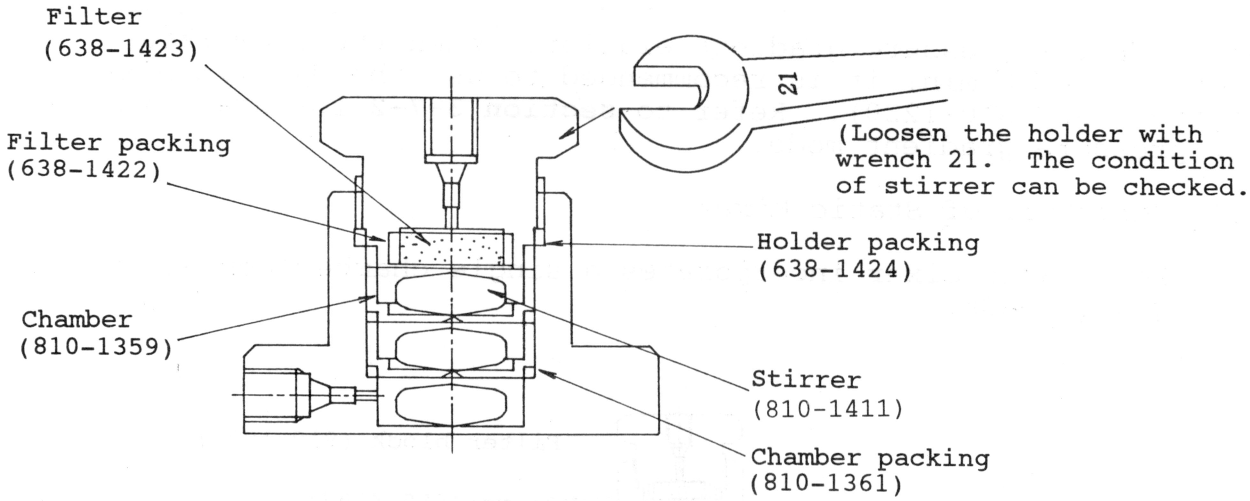
(e) Reassemble the static mixer by reversing the above procedure.

NOTICE:	Be careful not to drop the glass beads during disassembly.

7-5-2 Dynamic Mixer

(1) Structure of Dynamic Mixer

Three stirrer chambers are mounted in the dynamic mixer. This mixer is used for a high pressure gradient system or a low pressure gradient system beyond a flow rate of 2.0 mL/min. Refer to **section 3-7-2** for usage in the low pressure gradient mode.



(2) Maintenance

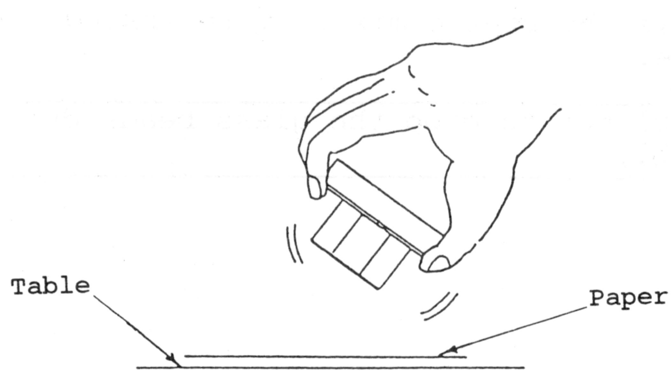
Open the chamber and check the degree of wear of the stirrer. Perform this every 6 months as a reference. If damage is heavy, the stirrer should be replaced with a new one furnished.
Stirrer should be replaced in the following procedure.

(a) Spread paper (wood free paper of size A3 or larger) on a table.

(b) Remove the filter of dynamic mixer with a wrench.

(c) Remove the screw which fastens each chamber and take out the chamber.

(d) Incline the chamber slightly and tap it against the table until the stirrer comes out.



(e) Put a new stirrer in the chamber and assemble the dynamic mixer by reversing the above procedure.

7-6 Maintenance and Checkup Method

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

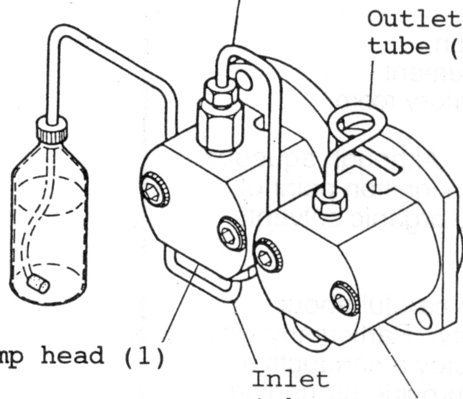
NOTICE: For usage of an ultrasonic cleaner, refrigerator, etc., refer to **their respective instruction manuals**.

7-6-1 Pump Seal Replacement

< Required Articles >

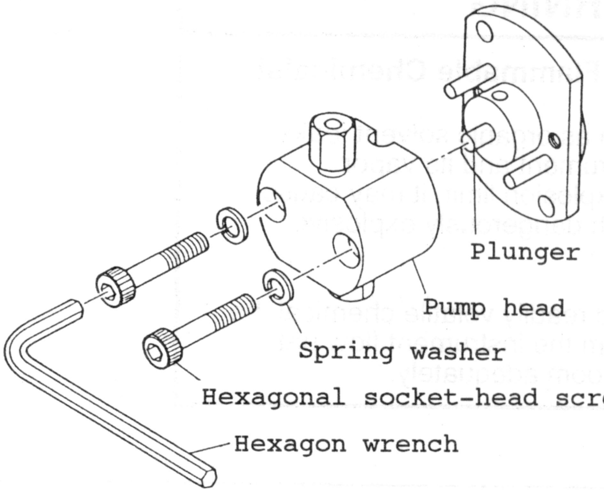
- Hexagon wrench
- 2 pump seals
- Washing bottle
- Ultrasonic cleaner
- Seal removal rod
- Gauze or soft cloth
- Receiving tray

(1)



(a) Remove the inlet tube and OUTLET tubes (1) and (2) from the pump head.

(2)

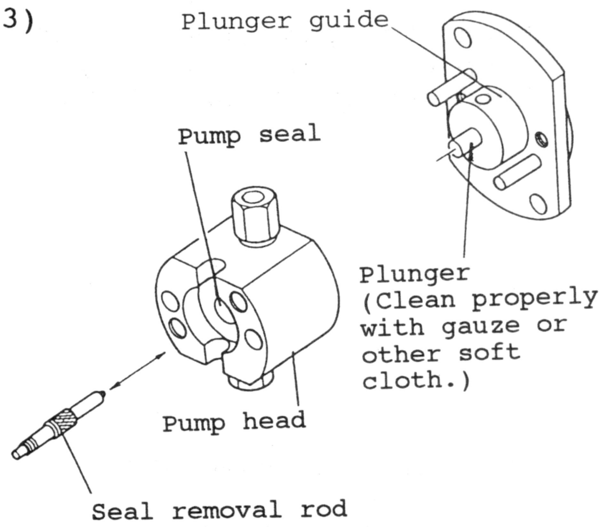


(b) Use the hexagon wrench to loosen the hexagonal socket-head screw of the pump head and remove it.

(c) Gently pull the pump head out with both hands. (For both the pump heads (1) and (2)).

NOTICE: Be careful not to bend the plunger.

(3)



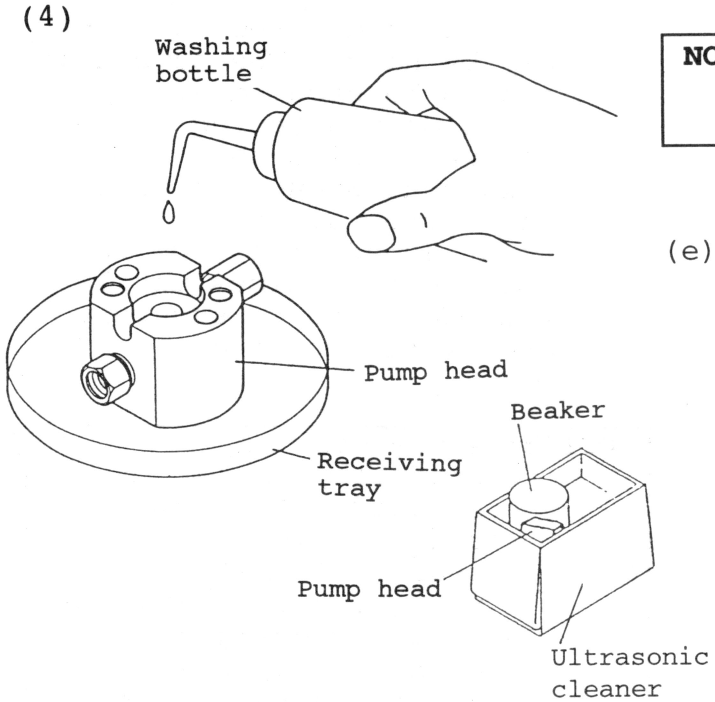
(d) Taking Out Pump Seal

(d)-1 When a pump seal remains inside the pump head, pull it out by screwing a seal removing rod into the pump seal.

(d)-2 If a pump seal remains inside with the plunger, start the pump and, as soon as the plunger comes out, stop the pump and pull out the seal.

(d)-3 Wipe the plunger with gauze or other soft cloth.

(4)

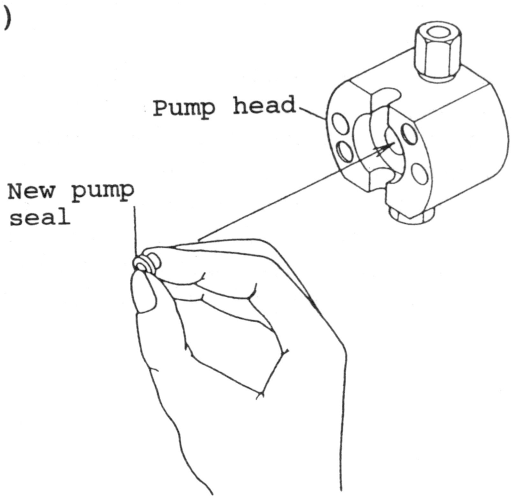


NOTICE:	Do not remove the seal inside the plunger guide.

(e) Washing Pump Head

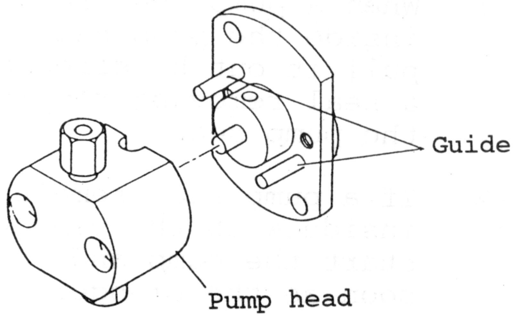
Wash the pump head thoroughly with distilled water or organic solvent, depending on the solvent that was used last. Wash with a neutral detergent and use an ultrasonic cleaner.

(5)



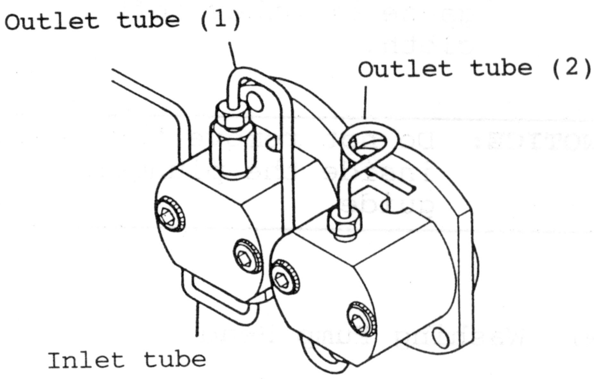
(f) Mount a new pump seal on the pump head.

(6)



(g) Mount the pump head on the pump by placing the pump head gently on the guides.

(7)

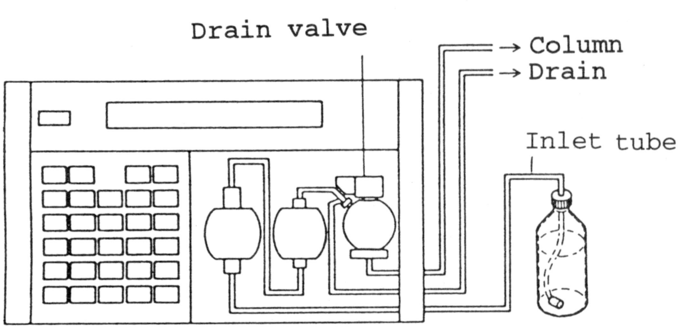


(h) Securing the Pump Head

Put on the spring washers and hexagonal socket-head screws. First tighten the socket-head screws all the way by hand. The pump head has to be secured evenly. One side tightening is not allowed. With the hexagonal wrench, tighten each screw alternately about 30 degrees. Do this about 4 or 5 times until the pump head is securely and evenly mounted.

> **NOTICE:** A new seal may gradually loosen as it is used. This can cause leaks. When a seal is loose, retighten the pump head with the hexagonal wrench using the described earlier.

(8)



(i) After you replace the pump seal, reconnect the tubes in the reverse order you removed them. Then, with the drain valve open, start the pump, and fill the pump head and tube with mobile phase to expel air bubbles.

7-6-2 Drain Valve Seal Replacement

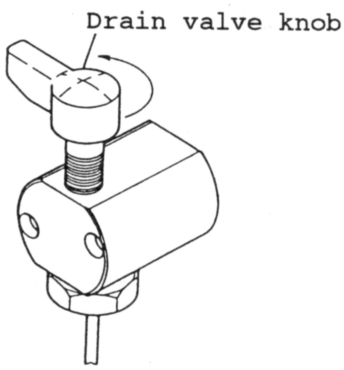
(1) How to Replace Valve Seal

If the liquid leaks from the drain tube with the drain valve closed, replace the valve seal with a new one.

< Required Articles >

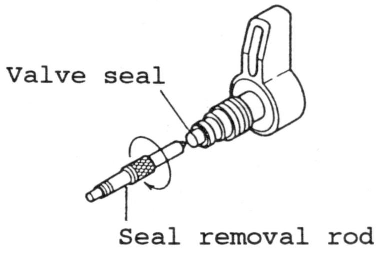
- Seal removal rod
- Seal (new part)

(1)



(a) Remove the door. Loosen the drain knob and pull it out.

(2)



(b) Insert the seal removal rod (thin side) into the valve seal part, and take it out.

(3)

(c) Attach a new valve seal at the end of drain knob shaft.

(d) Insert the drain knob into the valve unit and secure it.

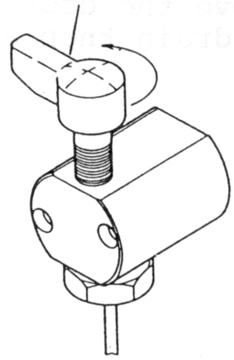
(2) How to Replace Drain Valve Packing

If liquid leaks around the knob of the drain valve when the valve knob closed, replace the packing ring.

< Required Articles >

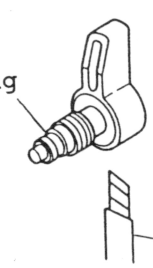
- Knife
- Packing (new part)

(1)



(a) Remove the door. Loosen the drain valve knob and pull it out.

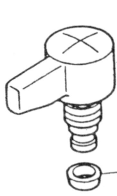
(2)



(b) Using a knife, remove the packing ring at the intermediate part of the drain valve knob.

NOTICE:	If using a cutter for the above, be careful not to cut yourself.

(3)



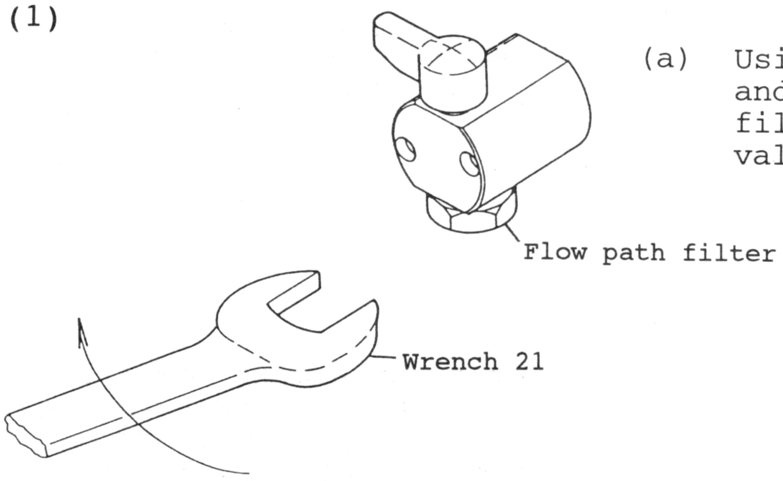
(c) Insert the drain valve knob into a new packing ring. Insert the knob straight so that the packing ring will not be damaged.

7-6-3 How to Wash the Flow Path Filter

< Required Articles >

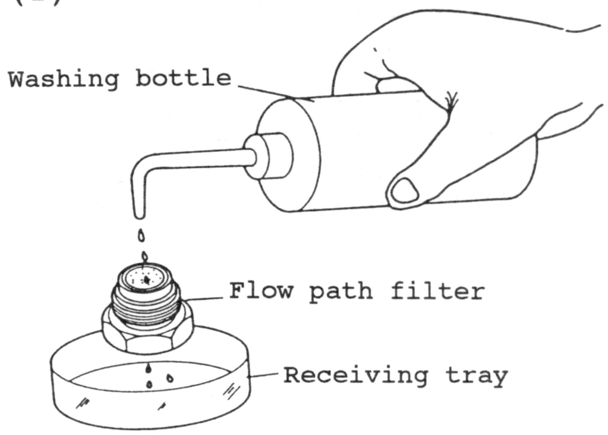
- Wrench 21
- New filter
- Washing bottle
- Receiving tray
- Ultrasonic cleaner
- Beaker

(1)



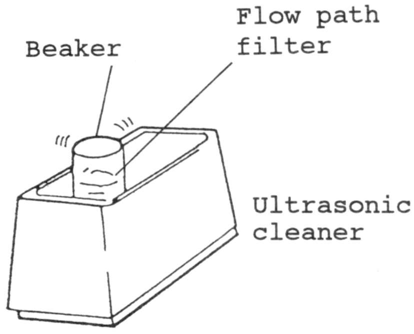
(a) Using the wrench 21, loosen and remove the flow path filter from the drain valve.

(2)



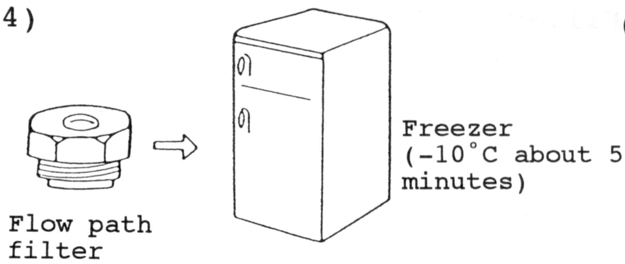
(b) Align the washing bottle nozzle with the filter outlet. Wash away foreign matter from the filter surface.

(3)



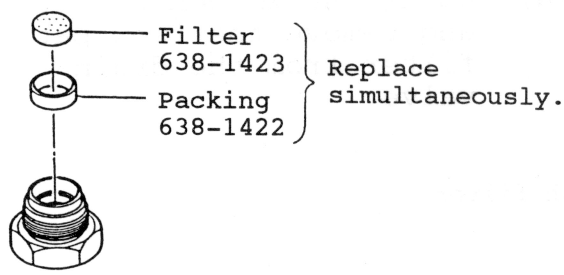
(c) Use an ultrasonic cleaner if the contamination is excessive.

(4)



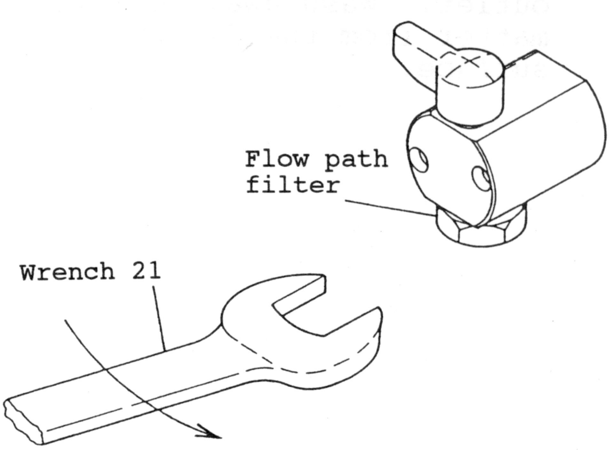
(d) If a clogged filter has to be replaced, allow the filter assembly to dry, then place it in a freezer (-10°C) for about five minutes. The cold temperature will contract the teflon packing and facilitate removal of the filter.

(5)



(e) Carefully push and mount the new filter into the filter holder.

(6)



(f) Before attaching the filter holder to the drain valve, clean the flow path by running the pump. Attach the filter holder to the lower right (canted) part of the drain valve.

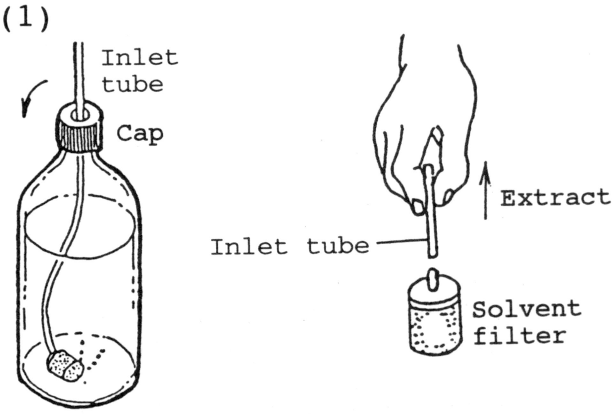
(g) Align the filter holder with the drain valve and tighten it securely with the wrench 21. Poor tightening may cause leaks.

7-6-4 How to Wash the Solvent Filter

< Required Articles >

- Beaker
- Washing liquid
- Ultrasonic cleaner

(1)

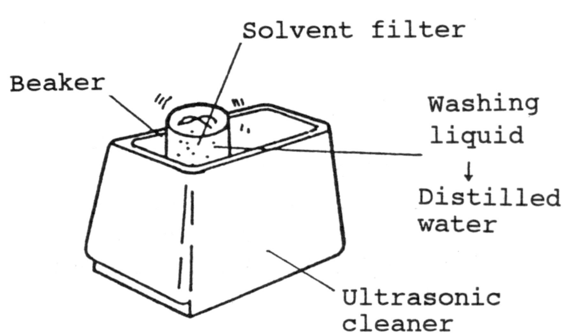


(a) Loosen the cap of the mobile phase bottle.

(b) Pull out the inlet tube from the mobile phase bottle.

(c) Remove the solvent filter from the inlet tube.

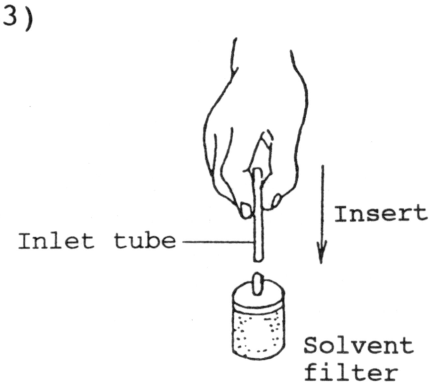
(2)



(d) Prepare the washing liquid in a beaker, and place the filter in it. Place the beaker in the ultrasonic bath. Run the ultrasonic cleaner for 5 to 6 minutes.

(e) Replace the washing liquid with distilled water. Run the ultrasonic cleaner for an additional 5 to 6 minutes. Repeat this operation three or more times to eliminate the washing liquid you use in step (d).

(3)



(f) After removing the moisture from the filter, mount on the inlet tube again.

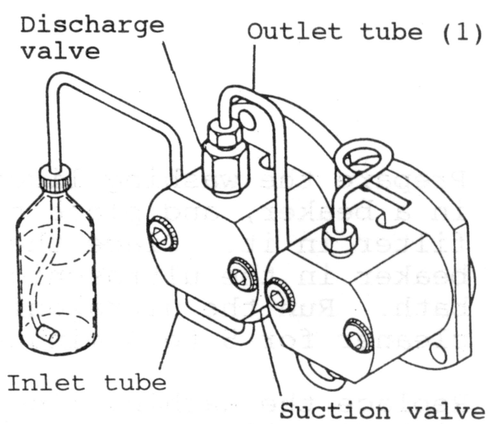
7-6-5 Washing of the Discharge Valve and the Suction Valve

Open the drain valve. Use isopropanol as the washing solvent. Flow the isopropanol for 3 to 5 minutes at a maximum flow rate of 9.999 mL/min. You may also use the PURGE function for this operation. If this procedure proves ineffective, take out and wash the valve following the procedure outlined next.

< Required Articles >

- Wrenches
- Washing liquid (neutral detergent)
- Beaker
- Ultrasonic cleaner
- Distilled water

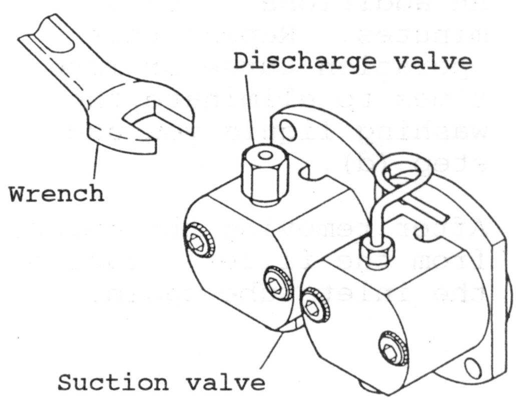
(1)



Make sure the pump head lock nuts are securely tightened.

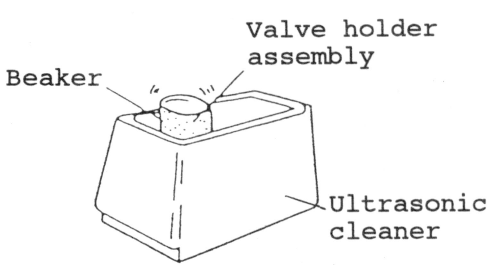
(a) Remove the inlet tube and OUTLET tubes from the suction valve and discharge valve.

(2)



(b) Loosen the suction valve and the discharge valve. Remove them along with the valve holder using the M10 wrench.

(3)



(c) Fill the beaker with the washing liquid (neutral detergent). Immerse the entire valve holder assembly into the beaker.

(d) Fill the ultrasonic cleaner with water. Put the beaker containing the valve holder assembly in it and perform washing for about ten minutes.

(e) Replace the detergent inside the beaker with the distilled water and perform ultrasonic washing for 5 to 6 minutes.
Repeat this operation three times or more to remove the detergent.

> **NOTICE:**
> The assembly structure of the discharge valve and the suction valve is shown in **Fig. 7-2**. If the packings (B) are disengaged and the inner parts come loose when washing, reassemble them using the illustration as a guide.
> Position the check valve so liquid enters from the valve seat side.
> One side of the check valve seat is glossy while the other side is not. When assembling the valve seat, set it so that the glossy side will be oriented to the ball contacting direction.

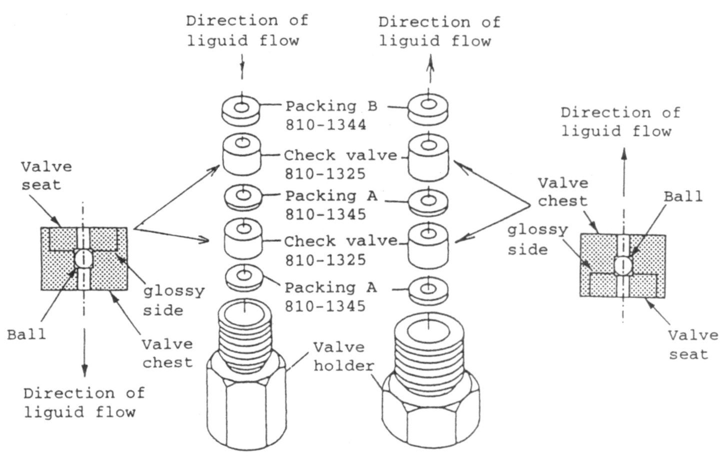
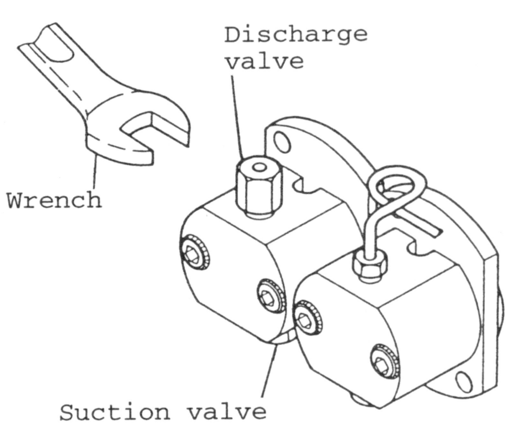


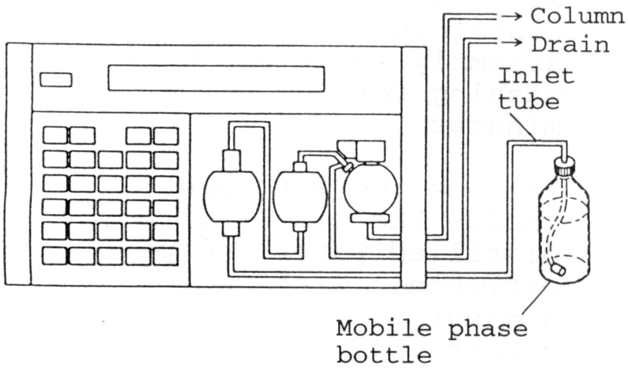
Fig. 7-2 Structures of Discharge and Suction Valves

(4)



(f) Position the valve holder on the pump head. Be careful that you do not reverse the suction and discharge sides.
Use wrench 10 to securely tighten both of them. If tightening is poor, suction will not occur.

(5)



(g) Install the inlet tube and OUTLET tubes, in the reverse order of their removal. With the drain valve open, start the pump to fill the pump head and tube with the mobile phase and to expel bubbles from the lines and the pump head.

(h) Connect a column and run the pump to make sure the pressure is stable.

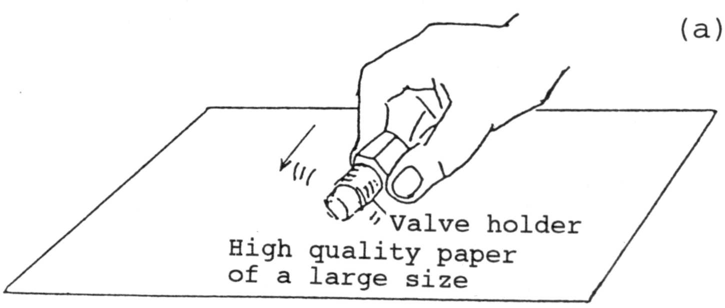
7-6-6 Parts Replacement for the Discharge Valve and the Suction Valve

After long use, the packings in the discharge valve and the suction valve may be damaged and cause leaks. If the leaks persist after retightening with a wrench, you must replace the packing.

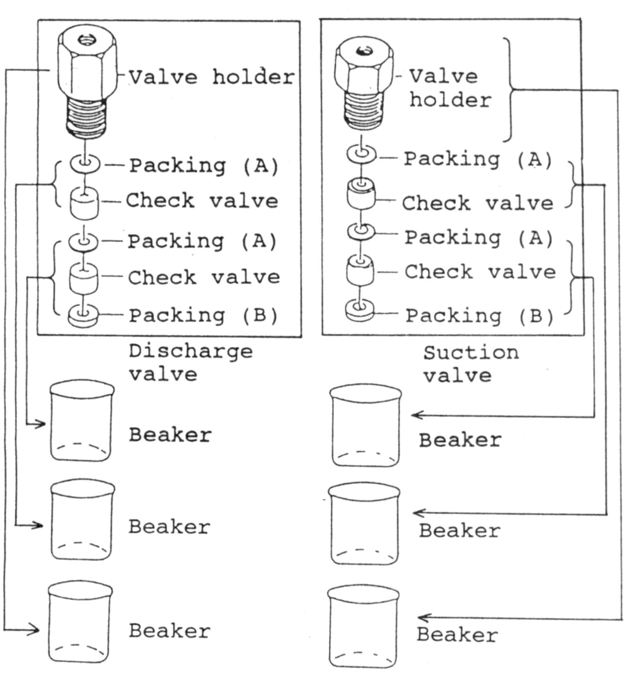
< Required Articles >

- Wrenches
- Washing liquid (distilled water)
- High quality paper
- Packings
- Several filter papers
- Beakers
- Ultrasonic cleaner

(1) Remove the discharge valve and the suction valve referring to figures a) and b) in 7-6-5.

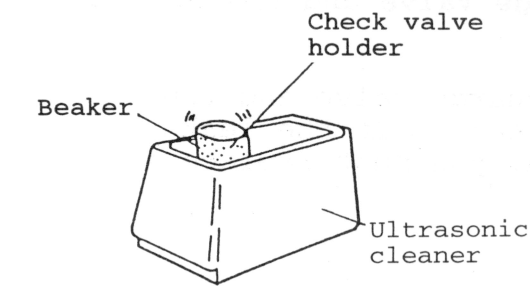


(a) Place a rather large piece of paper on a table. Remove the packing (B). Position the valve holder slightly aslant. Gently tap the valve holder against the table, and take out the check valves and packings from the inside.

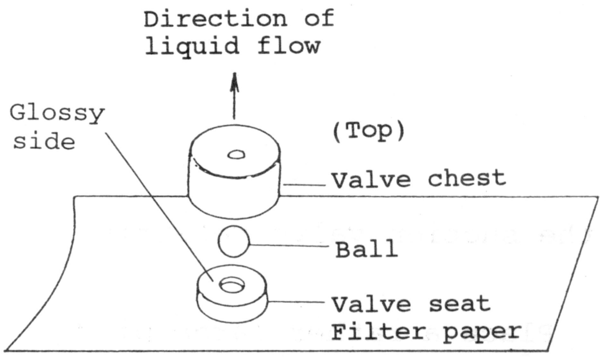


(b) Fill the beakers with the washing liquid (distilled water). Combine the new packings, valve chests, valve seats, and check valve balls as sets. Place them separately in each of the beakers. Place the valve holders in separate beakers also.

NOTICE: The ball and seat of the check valve are combined as a set. Be careful not to mistake the combination when disassembling and washing them.



(c) Fill the ultrasonic cleaner bath with water. Put the beakers in the ultrasonic cleaner bath and perform ultrasonic washing for 5 to 6 minutes.

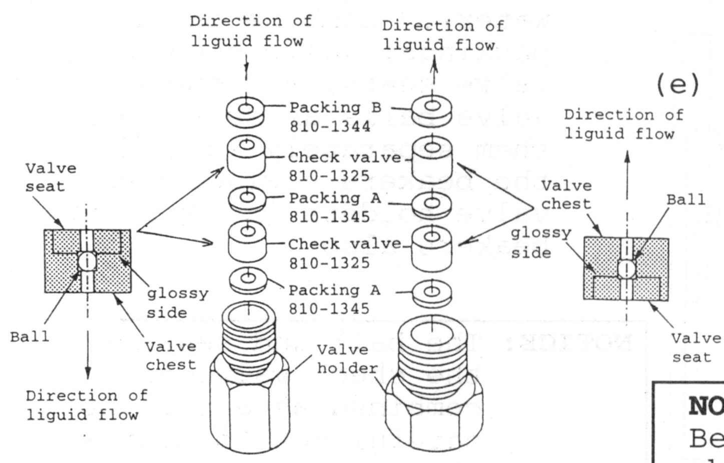


(d) Spread a large piece of filter paper on the table. In the following order, take out the valve chest, ball, and valve seat from the beaker. Use tweezers to avoid contamination. Then assemble the check valve using the correct procedure.

NOTICE:
When assembling, do not make a mistake in the check valve orientation and placement of the valve seat faces. The glossy side of the valve seat should face the ball.

NOTICE:
The valve seat and ball are used as a pair. Be sure to assemble the same pair together.

Sufficiently dry the valve holder and packings.



(e) Mount the assembled check valves into the valve holder in the order shown in the illustration.

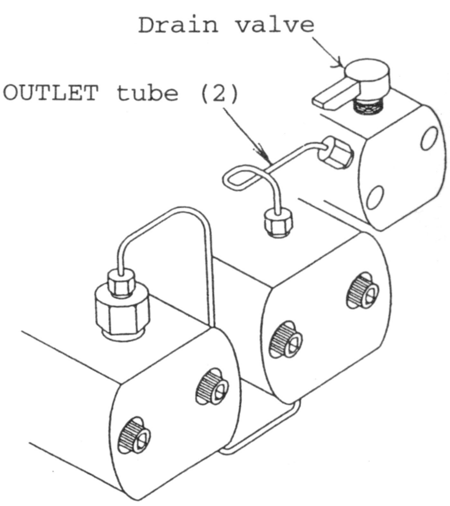
NOTICE:
Be careful not to mistake the check valve orientation and to the packing size.

(2) Mount the discharge valve and suction valve on the pump head. Make sure that the flow direction of the liquid supply is correct. Refer to (f) through (h) in 7-6-5.

NOTICE: When assembling, do not exchange the suction and discharge sides.

7-6-7 Cleaning of OUTLET Tube (2)

< Required Articles >
- Wrench
- Beaker
- Washing liquid (distilled water)



(a) Remove the screw on the drain valve side of OUTLET tube (2).

(b) Place a beaker at the exit of OUTLET tube (2).

(c) Supply the washing liquid to rinse out the tube.

(d) Reattach the screw on the drain valve side of OUTLET tube (2).

7-7 Fuse Replacement

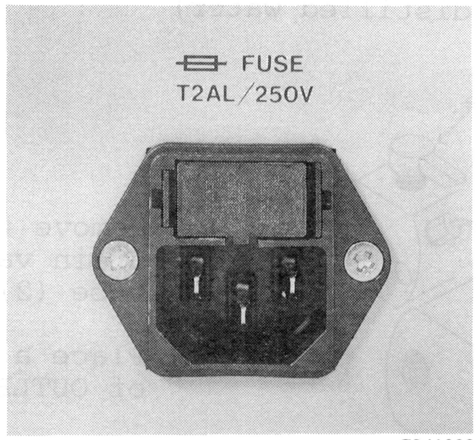
> **⚠ WARNING**
>
> **Beware of Electric Shock !**
>
> For fuse replacement, make sure to turn OFF the power switch and disconnect the power cord from the instrument.

(1) Required items : New fuse (P/N J821335)
Be sure to use a time lag fuse of the specified rating (T2AL).

(2) Check item : Make sure that the power switch of the pump is turned off and that the power cord is disconnected from the pump.

(3) Replacement

(a) Grip the claw at each side of the fuse holder and pull out the fuse holder.



C941322

(b) After taking out the old fuse, replace it with a new fuse.

(c) Return the fuse holder to the original position.

7-8 Precaution on Instrument Failure

NOTICE: If the instrument becomes faulty, contact the dealer from whom you purchased the instrument or the nearest Hitachi service agent. Repair must be left to service personnel who have undergone Hitachi's technical training since there are potential hazards.

⚠ WARNING
Beware of Electric Shock !
Before removing the instrument cover for parts replacement, etc., make sure to turn OFF the power switch and disconnect the power cord from the receptacle.

8. REPLACEMENT PARTS

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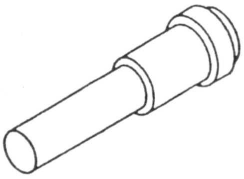
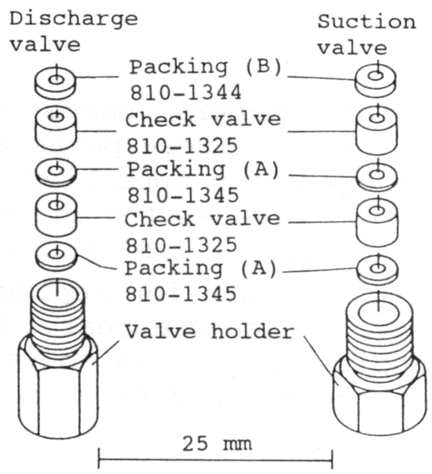
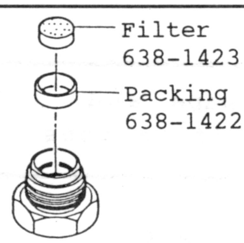
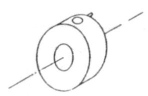
8. REPLACEMENT PARTS

The following table lists part numbers, names, shapes, specifications, etc. of replacement parts. These parts are necessary to keep the system in optimum operation condition. Use this when ordering parts. Normal life indicates the lifetime of the part when supplying methanol at a rate of 1 mL/min and pressure of 19.6 MPa (200 kgf/cm^2). The standard for replacement is based on operation for 8 hours daily, 240 days a year. These figures vary greatly with the usage conditions such as solvents used, flow rate and pressure, and should be determined through actual use.

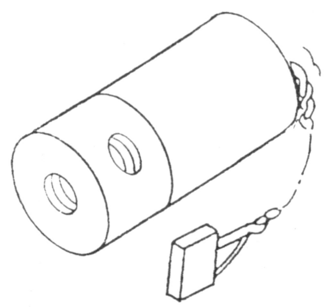
8-1 Model L-7100 Pump

Part No.	Name	Shape and Specifications	Position Used (expected life)	Normal Life
655-1080	Seal		Seal pump (4 months)	640 hrs
885-2920	Seal		Seal drain valve (1 year)	1920 hrs
810-1033	Plunger		Pump (—)	—

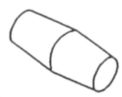
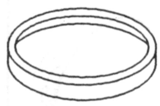
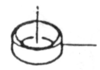
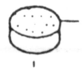
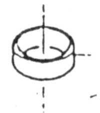
(cont'd)

Part No.	Name	Shape and Specifications	Position Used (expected life)	Normal Life
810-1005	Check valve (on discharge valve)		Pump (—) If check valve doesn't work properly, clean it according to section 7-6-5 or 7-6-6 in the manual. If this doesn't solve the problem, replace the valve.	—
810-1004	Check valve (on suction valve)			
810-1031	Flow path filter		Drain valve (1 year)	1920 hrs
810-1046	Packing		Drain valve (1 year)	1920 hrs
810-1008	Plunger guide		Pump (1 year)	1920 hrs

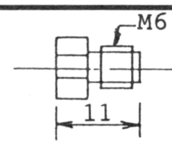
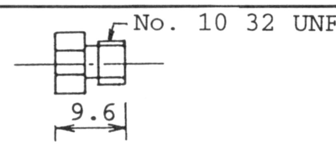
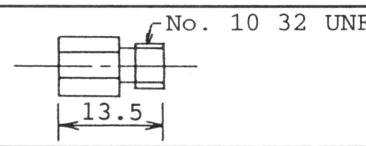
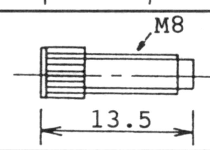
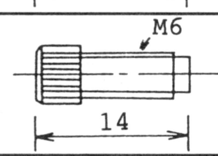
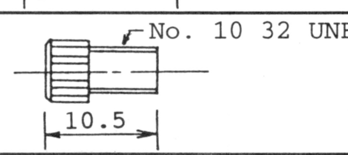
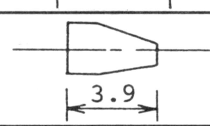
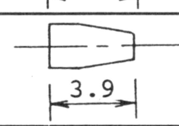
8-2 Gradient Parts for Model L-7100

Part No.	Name	Shape and Specifications	Position Used (expected life)	Normal Life
885-1505	Packing		For 4-way joint (1 year)	1920 hrs
810-1335	Solenoid valve A Solenoid valve B Solenoid valve C Solenoid valve D		Proportioning valve 1 each of A, B, C and D. The solenoid valve is an expendable. Its normal life varies greatly with usage conditions. Before use, make sure its screw part is tight. If liquid leakage occurs, retighten the screw. If this doesn't stop the leakage, replace the valve.	1920 hrs

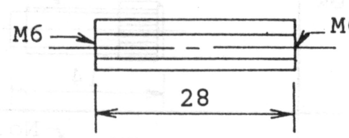
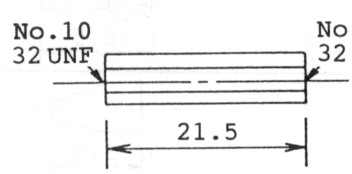
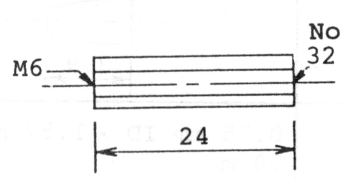
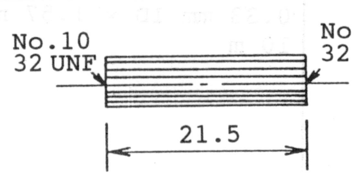
8-3 Dynamic Mixer Parts

Part No.	Name	Shape and Specifications	Position Used (expected life)	Normal Life
810-1411	Stirrer		Dynamic mixer (6 months)	810 hrs
810-1361	Chamber packing		Dynamic mixer (1 year)	1920 hrs
638-1422	Filter packing		Dynamic mixer (1 yaear)	1920 hrs
638-1423	Filter		Dynamic mixer (1 year)	1920 hrs
638-1424	Holder packing		Dynamic mixer (1 year)	1920 hrs

8-4 Flow Path Tubing Parts

Part No.	Name	Shape and Specifications	Position Used
L329235	SUS push screw (M6)		1/16 inch (1.57 mm) OD SUS pipe
655-1458	SUS push screw S		1/16 inch (1.57 mm) OD SUS pipe, Rheodyne injector
655-1459	SUS push screw M		1/16 inch (1.57 mm) OD SUS pipe, Rheodyne injector
810-1310	PCTFE push screw (3.2 ID)		3 mm OD PTFE tube
810-1311	PCTFE push screw (2.2 ID)		2 mm OD PTFE tube
810-1312	PCTFE push screw (2.1 ID)		2 mm OD PTFE tube
638-1099	SUS ferrule (SUS 316) 1/16 inch		1/16 inch OD SUS pipe
L369053	PCTFE ferrule 1/16 inch		1/16 inch PTFE tube
F275108	PTFE tube	0.25 mm ID × 1.57 mm OD × 10 m	Inlet tube for UV detector
F275144	PTFE tube	0.33 mm ID × 1.57 mm OD × 10 m	· Outlet tube for UV detector · UV detector back pressure tube for high pressure gradient elution · Reaction coil for reaction LC
F275112	PTFE tube	0.5 mm ID × 1.5 mm OD × 10 m	· For tubing connection with reaction pump · Inlet/outlet tube for collecting cell

(cont'd)

Part No.	Name	Shape and Specifications	Position Used
F275114	PTFE tube	1.0 mm ID × 2.0 mm OD × 10 m	Connecting tube between proportioning valve and pump
638-1140	PTFE tube	1.5 mm ID × 3.0 mm OD × 10 m	Solvent suction tube for pump
634-1976	Stainless steel pipe	0.25 mm ID × 1.57 mm OD × 5 m	· Pipe for high pressure gradient elution · Pipe for between injector and column
634-1977	Stainless steel pipe	0.5 mm ID × 1.57 mm OD × 10 m	Inlet/outlet pipe for dynamic mixer
638-2185	Stainless steel pipe	0.8 mm ID × 1.57 mm OD × 4 m	Internal pipe in pump, drain pipe
633-1263	Nipple (made of SUS)		1/16 - 1/16 pipe connection
885-1602	Nipple (made of SUS)		Same as above
885-1601	Nipple (made of SUS)		Same as above
885-2179	Nipple (made of Daiflon)		Same as above

9. SPECIFICATIONS

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9. SPECIFICATIONS

9-1 Pump Unit

(1) Liquid feed system:

Dual plunger type reciprocating pump, series connection

(2) Maximum discharge pressure:

39.2 MPa (400 kgf/cm^2)

(3) Discharge rate range:

0.001 to 9.999 mL/min

(4) Pressure limit range:

0 to 41.2 MPa

(5) Discharge volume of plunger no. 1:

100 µL/stroke

(6) Flow rate setting accuracy (at constant room temperature of 20°C for distilled water):

- ±2 µL/min (0.01 to 0.1 mL/min, 1.0 to 39.2 MPa)
- ±2% (0.101 to 5 mL/min, 1.0 to 39.2 MPa)
- ±2% (5.001 to 9.999 mL/min, 1.0 to 2.0 MPa)
- +2% to -1p*% of discharge pressure
  (5.001 to 9.999 mL/min, 2.1 to 39.2 MPa)

*p ..... Pump pressure (MPa)

(7) Flow rate stability:

0.2% RSD or less (retention time at flow rate 1 mL/min, at constant room temperature of 20°C for distilled water)

(8) Compensation of solvent compression ratio and elimination of pulsation:

High-speed feedback real-time control

(9) Pressure display accuracy:

±5%

(10) Constant pressure liquid feed:

2.0 to 39.2 MPa (20 to 400 kgf/cm^2)
(Flow rate range: 0 to 5 mL/min)

(11) Material of wetted parts:

SUS 316, ruby, sapphire, ceramic, PTFE carbon-impregnated PTFE

(12) Display data:

Parameters

Pump monitor	Flow rate, pressure
Gradient monitor ...	Elapsed time, mixing ratio, flow rate, pressure, timer value, etc.

(13) Pump control mode:

- Single-liquid delivery mode
- Low pressure gradient mode
- High pressure gradient mode

(14) Contact input/output terminals:

Event timer: 4 channels

(15) External communication:

D-line

(a) D-line commmunication mode (D-line ON)

(b) D-line contact mode (D-line OFF)
OUTPUT PUSY/READY
INPUT 1) GRADIENT START
2) EMERGENCCY STOP

(16) Specification of pressure unit:

MPa, kgf/cm^2, bar, psi

(17) Pressure zero adjustment:

Possible

(18) Ambient temperature:

4 to 35°C (condensation unallowable)

(19) Humidity:

45 to 85% RH

(20) Power supply:

100 to 240 V AC ± 10%

10. COMMUNICATION

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10. COMMUNICATION

10-1 Communication Function via the D-line

D-line is Hitachi's exclusive digital network. This network has been developed for automating the analysis of liquid chromatography instrumentation. In the D-line configuration, data exchange and control between instruments is possible via a single cable.

The D-line network is an analysis-oriented digital network that has been developed by Hitachi for automatic operation of liquid chromatograph system. In the D-line network, data transmission and instrument control can be carried out through the dedicated cables.

D-line network
- D-line communication mode (D-line ON)
- D-line contact mode (D-line OFF)

NOTICE 1:	This D-line network is applicable for communication only among the modules having D-line function.
NOTICE 2:	Conversion between contact signals and D-line signals can be made using the optional relay box. Note, however, that some restrictions are imposed on communication.

(1) D-line Communication Mode

In the D-line communication mode, the following communication functions are available for the connected instruments.

(a) Output of READY/BUSY Signal

When the D-line communication mode connected unit is ready, it outputs the READY signal. In this state, the chromatograph system can be started by pressing the ALL START key on the D-7500.
When the D-line communication connected unit is busy, it outputs the BUSY signal. In this state, the chromatograph system cannot be started even if the ALL START key is pressed on the D-7500.

(b) The analytical parameters specified for the D-line communication mode connected unit can be printed out on the D-7500.

(c) The logbook data of the D-line communication mode connected unit can be printed out on the D-7500.

(d) If an error occurs in the D-line communication mode connected unit, the relevant message is displayed on the D-7500.

(e) The keyboard of the D-line communication mode connected unit can be locked by pressing the KEY LOCK button on the D-7500.

(2) D-line Contact Mode

In the D-line contact mode, the following three kinds of signals are available.

(a) START (pulse signal)

Use the START signal to start the time program for the unit in D-line network or synchronize the external unit start timing with the unit in D-line network.

(b) ERROR STOP
(Level signal: ERROR STOP = CLOSE [LOW])

Use the ERROR STOP signal to stop the unit in D-line network in the event of emergency or stop the external unit on occurrence of an error at the unit in D-line network.

(c) BUSY
(Level signal: BUSY = CLOSE [LOW])

Use the BUSY signal to communicate the status data between the unit in D-line network and the external unit.

10-2 Gradient Program Printout

You can print the contents of a program resident in the Model L-7100 at the Model D-7500 Integrator.

10-2-1 Contents of the Gradient Program Printout

Table 10-1 lists the contents of a printout in the Model D-7500.

Table 10-1 Contents of a Gradient Program Printout

Printout Item	Description
PROGRAM No.	No. of program
PRESSURE VALUE	Upper and lower limit pressure values
TIME	Time point
COCENTRATION	Mixing ratio of mobile phase at each time point
FLOW	Flow rate at each time point
EVENT	Event at each time point

10-2-2 Setting for the Gradient Program Printout

Use the UTILITY function of the Model L-7100 to specify a Gradient Program Printout.

Monitor screen

↓ [UTILITY (SET UP)]

```
UTILITY:  COND.=1, UNIT=2, PRINT=3,      [--]
<1-6>  1  FLUSH=4, EVENT=5, LINK=6
```

↓ Select PRINT.

[3] [ENTER]

```
PRINT:    PROGRAM=1, GR-CURVE=2,         [--]
<1-3>  1 LOGBOOK=3
```

↓ Select PROGRAM.

[1] [ENTER]

```
PRINT PROGRAM No.?                        [--]
<1-9>          1
```

↓ Input the number of the program to be printed.
You can select a program number from 1 to 9.

(EX.: [1] [ENTER])

Moniter screen

```
PROGRAM No.  =  1

PRESSURE VALUE :  MAX    MIN           MPa
                  41.2   0.0

     TIME              CONCENTRATION                FLOW              EVENT
     (min)      %A      %B      %C      %D      (ml/min)     1    2    3    4

      0.0      100       0       0       0       1.000      12   22   32   42
      4.0        0      50      50       0
      6.0        0      50      25      25
      8.0        0       0       0     100
     10.0        0       0       0     100       6.000
```

* This is an example of printout in the low pressure gradient mode.
  In the single-liquid delivery mode, %B, %C and %D do not display.
  In the two-liquid high pressure gradient mode, %C and %D do not display.
  In the three-liquid high pressure gradient mode, %D does not display.
  In the high pressure gradient mode, the mixing ratio of each mobile phase displays down to the first decimal place.

Fig. 10-1 Typical Gradient Program Printout

10-3 Gradient Curve Printout

You can print the gradient curve in a program generated in the Model L-7100 at the Model D-7500 Integrator.

10-3-1 Contents of the Gradient Curve Printout

Table 10-2 lists the contents of a Gradient Curve Printout in the Model D-7500.

Table 10-2 Contents of the Gradient Printout

Printout Item	Description
Flow rate	Outputs the change in the flow rate.
Mixing ratio of mobile phase	%B (low pressure gradient/high pressure gradient) %B + %C (low pressure gradient/three-liquid high pressure gradient) %B + %C + %D (low pressure gradient)

10-3-2 Setting for the Gradient Curve Printout

Use the UTILITY function of the Model L-7100 to select the Gradient Curve Printout.

Monitor screen

UTILITY (SET UP)

```
UTILITY :  COND.=1, UNIT=2, PRINT=3,        [--]
<1-6>  1   FLUSH=4, EVENT=5, LINK=6
```

Select PRINT.

3 ENTER

```
PRINT :  PROGRAM=1, GR-CURVE=2,              [--]
<1-3>  1 LOGBOOK=3
```

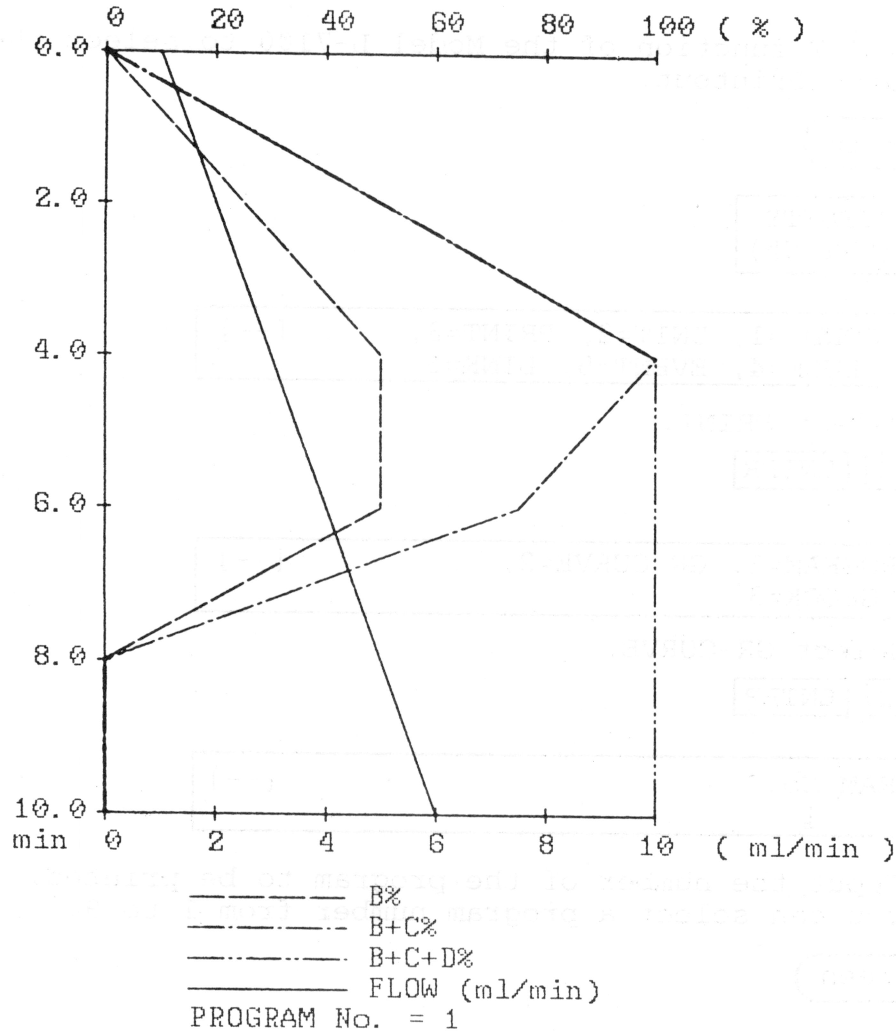
Select GR-CURVE.

2 ENTER

```
PRINT PROGRAM No.?                           [--]
<1-9>          1
```

Input the number of the program to be printed.
You can select a program number from 1 to 9.

Monitor screen



In the single-liquid delivery mode, B%, B+C% and B+C+D% do not print.

In the two-liquid high pressure gradient mode, B+C% and B+C+D% do not print.

In the three-liquid high pressure gradient mode, B+C+D% do not print.

Fig. 10-2 Printout of Gradient Curve

10-4 Logbook Printout

You can print the contents of the logbook and UTILITY in the Model L-7100 pump at the Model D-7500 Integrator.

10-4-1 Contents of the Logbook Printout

Table 10-3 lists the contents of logbook that will print.

Table 10-3 Contents of Logbook Printout

Printout Item	Description
Program No.	Program number
Total amount of solvent	Total liguid delivery after replacement of the pump seal
DATE: MM/DD/YY	Date of the pump seal replacement (You need to input the date.)
MOTOR CONTROL	Pump motor control method. In case of FIX, a value of Fix is printed also.
L.P. GR TYPE	Low pressure gradient type
AUTO STOP	Pump auto-stop setting
DELAY TIME	Waiting time. Not printed when AUTO STOP is set to NO.
COLUMN FLUSH	Column flush condition. Not printed when AUTO STOP is set to NO.
LINK PROGRAM	Link program condition

10-4-2 Setting for the Logbook Printout

Use the UTILITY function of the Model L-7100 to specify a logbook printout.

Monitor screen

UTILITY (SET UP)

```
UTILITY :  COND.=1, UNIT=2, PRINT=3,          [--]
<1-6>  1   FLUSH=4, EVENT=5, LINK=6
```

Select PRINT

3 ENTER

```
PRINT :  PROGRAM=1, GR-CURVE=2,               [--]
<1-3>  1 LOGBOOK=3
```

Select LOGBOOK.

3 ENTER

Monitor screen

```
PUMP LOGBOOK

PROGRAM No.                      =  8107805-04    <--- Subject to change
TOTAL AMOUNT OF SOLVENT(1)       =      0
           (DATE:MM/DD/YY)       =  01/01/01

UTILITY

MOTOR CONTROL                    =  STANDARD
L.P.GR TYPE                      =  SLOW
AUTO STOP                        =  YES
DELAY TIME                       =  600.0     min
COLUMN  FLUSH                    =  YES
  A%                             =  100       %
  B%                             =    0       %
  C%                             =    0       %
  D%                             =    0       %
  FLOW                           =  1.000     ml/min
  TIME                           =    1.0     min

LINK PROGRAM                     =  YES

  STEP    PROG-No.    CYCLE     COND. TIME(min)
   1         1          1          10.0
   2         2          1          10.0
```

Not printed when NO is set for COLUMN FLUSH.

Not printed when NO is set for AUTO STOP.

Not printed when NO is set for LINK PROGRAM.

Fig. 10-3 Printout of Logbook

10-5 Start/Stop via the D-line Communication

Use the ALL START key of the Model D-7500 when you want to start and stop all instruments via the D-line communication. The start key is capable of starting both the Model L-7100 and the L-7400 simultaneously. When the autosampler is connected, use the START key of the autosampler to start all units. When the detector lamp filament burns out or any error occurs during the system operation, an error signal is sent from the Model L-7400 to the integrator via the D-line communication.
Further, the integrator sends the error signal to the Model L-7100 pump to stop it.
When the Model L-7200 sends an all stop signal, the Model L-7100 stops or the flush program starts.

10-6 Installation

In order to print a gradient program, gradient curve, or a logbook of the Model L-7100 pump at the Model D-7500 Integrator, plug the D-line cable into each D-line terminal at the back panel of the Model L-7100 and at the back panel of the Model D-7500.

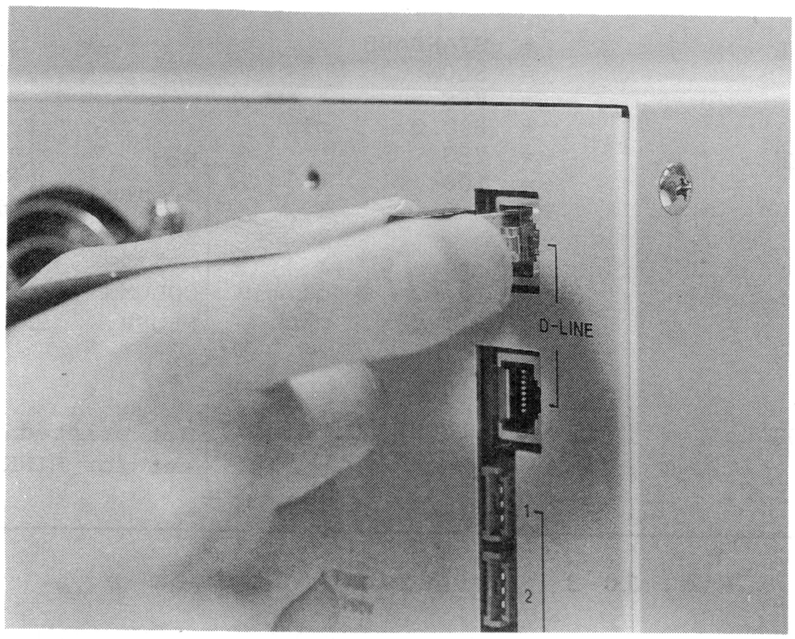


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Fig. 10-4 D-line Connection

The Model L-7100 has two D-line terminals. The component units are linked to each other by connecting one terminal of the Model D-7500 to the Model L-7400, etc. In this way, a single cable line covers the entire range from system control to detector signal.

NOTICE 1:	If only the D-7500 is turned off and then on again after initialization of the peripheral devices (L-7100 pump, L-7200 auto sampler, L-7400 UV detector, etc.), the D-7500 cannot recognize which deveces are connected with it. In this case, turn off the peripheral devices and then on again also.
NOTICE 2:	If the D-line error takes place, turn off all the units and then on again.

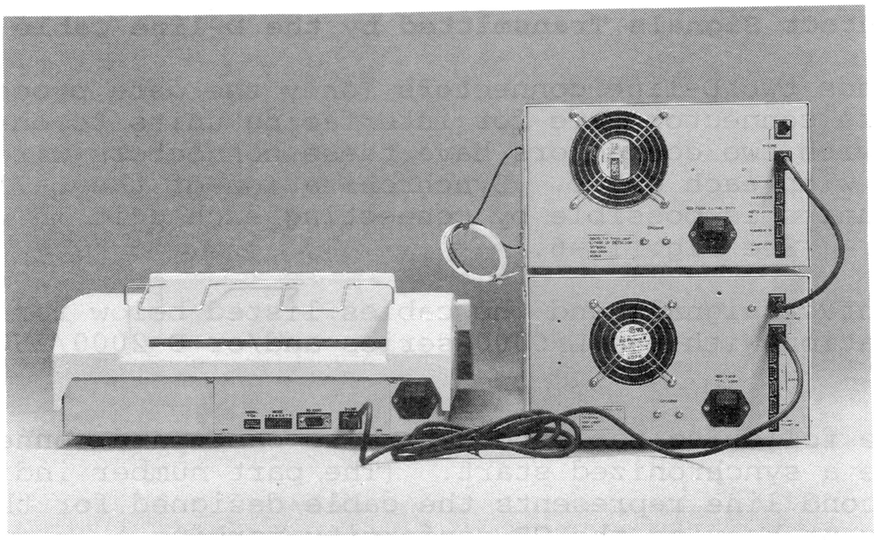

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Fig. 10-5 System Connection

10-7 Contact Signals Description

10-7-1 Outline

The L-7100 uses two types of contact signals.

(1) Contact Signals (START, STOP, BUSY) Transmitted by the D-line Cable

These contact signals have input/output functions which are common to each unit. These signals comprise the START (IN/OUT), STOP (IN/OUT) and BUSY (IN/OUT) commands. They are valid when the D-line is turned OFF via the setup function of each unit.

(2) Individual Contact Signals Used by Each Unit

These are contact signals which are input and output via a 3-pin connector, and their names and functions vary with each unit. Each connector has a name to indicate the function.

Example of output contact signal:
EVENT in the pump
Example of input contact signal :
LAMP OFF IN of detector
SERIES START IN of autosampler

10-7-2 Contact Signals Transmitted by the D-line Cable

Each unit has two D-line connectors (only the data processor has one). These connectors are for interfacing units to one another. The units with two connectors have these connectors wired internally with each other. Synchronization of the L-7100 with all other units is possible by connecting each unit in series via the D-line. (See Fig. 10-6.)

Use the contact signals and the cables listed below for synchronization with the L-6000 series and/or D-2000/2500 or D-6000/6500.

(1) Use the following table to determine cable and connections to achieve a synchronized start. (The part number indicated on the second line represents the cable designed for the instrument bearing the CE conformity marking.)

Part No.	Part Name	Opposing Terminal	Opposing Device (example)
810-7634 810-7514	SDIO(START 3P) cable FDIO(START 3P) cable	3P connector	L-6200, D-6000
810-7633 810-7513	SDIO(START M3) cable FDIO(START M3) cable	M3 terminal	L-5000
810-7632 810-7512	SDIO(START M4) cable FDIO(START M4) cable	M4 terminal	D-2500/2000

(2) Use the following table to determine cable and connections to achieve synchronized ready/busy and stop as well as start. (The part number indicated on the second line represents the cable designed for the instrument bearing the CE conformity marking.)

Part No.	**Part Name**	**Opposing Terminal**	**Opposing Device (example)**
810-7631 810-7511	SDIO cable FDIO cable	3P connector	L-6200, D-6000

If the connecting terminal is other than the 3P connector, it is necessary to connect a separate cable at the end of the SDIO cable.

NOTICE:
1. Be sure to use the cables indicated by us for connection of the contact signals.
2. For synchronization of contact signals with multiple units that are not part of the L-7000 series, use the relay box (P/N 810-7630).
3. The contact terminals have polarity. Be careful not to reverse the polarity when making connections.
4. The voltage applied across contact terminals must not exceed 30 V.
5. When shorting across contact terminals, a maximum current of 10 mA will flow per unit. If you connect multiple units via the D-line cable, this current will be added. Use contacts that can accept a current of 0.1 A or greater for the contact start circuitry on the opposite side.
6. The maximum current of the contact output (start) circuit is 0.1 A. Check the contact signal reception circuit in the opposite side before making a connection.
7. For a diagram of the D-line contact circuit, refer to **Fig. 10-7**.

10-7-3 Individual Contacts of Each Unit

(1) Contact signal Input Terminals

These are contact signal input terminals for control when using contact signals from an external switch, relay, etc. Any of the signals can be made active by shorting the terminal for 0.1 second or longer. The input circuitry is shown in Fig. 10-8.

(2) Contact Signal Output Terminals

These are contact signal output terminals for control using contact signals of an external unit. The output circuit is shown in Fig. 10-9. The rating of contacts used is 30 V, 0.1 A. Make sure the load you connect does not exceed that rating.

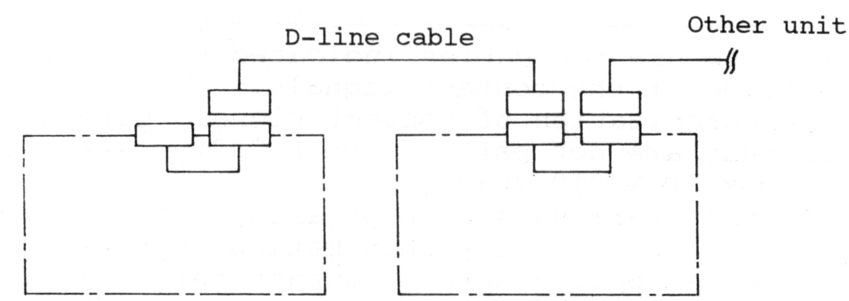


Fig. 10-6 D-line Cable Connection

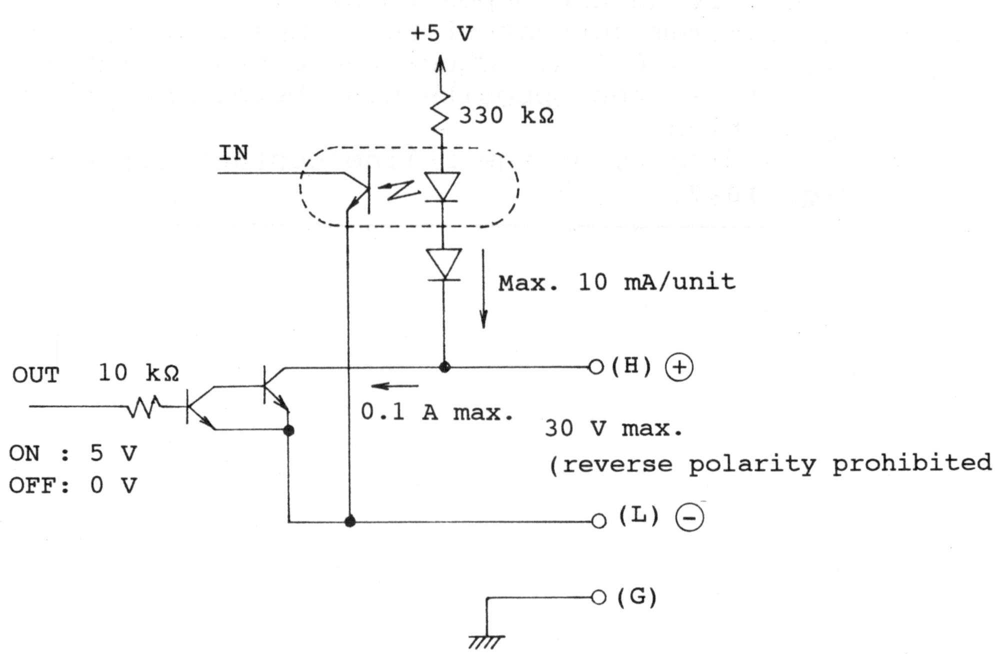
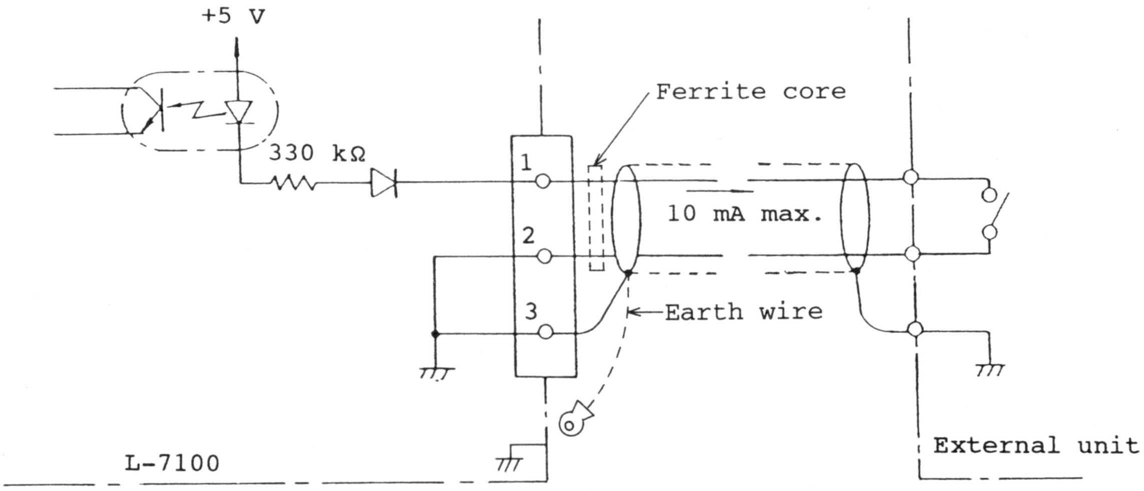


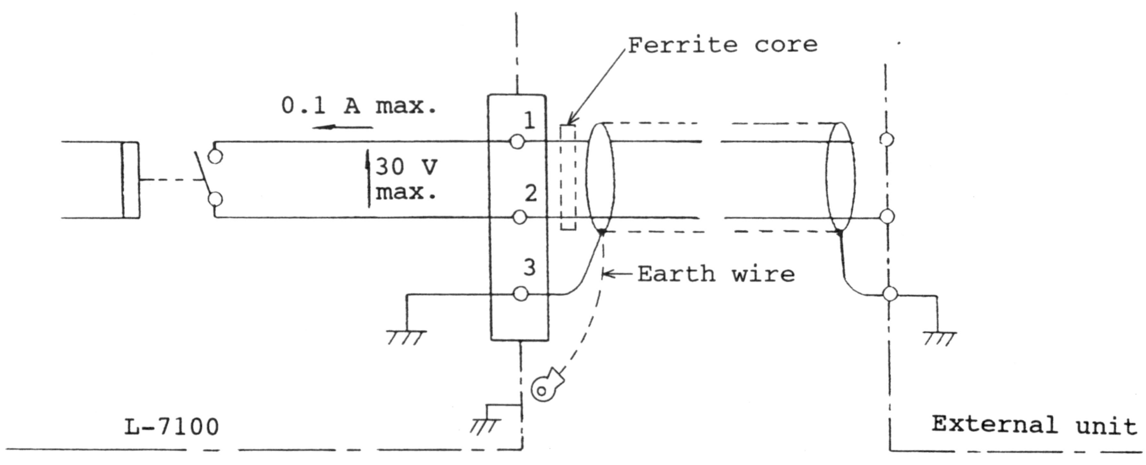
Fig. 10-7 D-line Contact Circuit Configuration



Activated upon shorting contacts of external unit.
---: For instrument bearing the CE conformity marking.

Fig. 10-8 Contact Signal Input Circuit

NOTICE:	For connection with the instrument bearing the CE conformity marking, use the dedicated cable with ferrite core and connect earth wire to ground (ground mark).



---: For instrument bearing the CE conformity marking.

Fig. 10-9 Contact Signal Output Circuit

NOTICE:	For connection with the instrument bearing the CE conformity marking, use the dedicated cable with ferrite core and connect earth wire to ground (ground mark).

11. WASTE LIQUID TUBE SET (OPTION)

11. WASTE LIQUID TUBE SET (OPTION)

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

Each L-7000 series unit has a pan inside it for collecting waste liquid (leaking liquid) if liquid leakage occurs in each unit. When installing the waste liquid tube set (option)(P/N 810-1398) in each unit, the waste liquid discharged from the pans in all units can be gathered at the same place. For installing the waste liquid tube set, its holder, tube and pans should be placed as shown in Fig. 11-1.

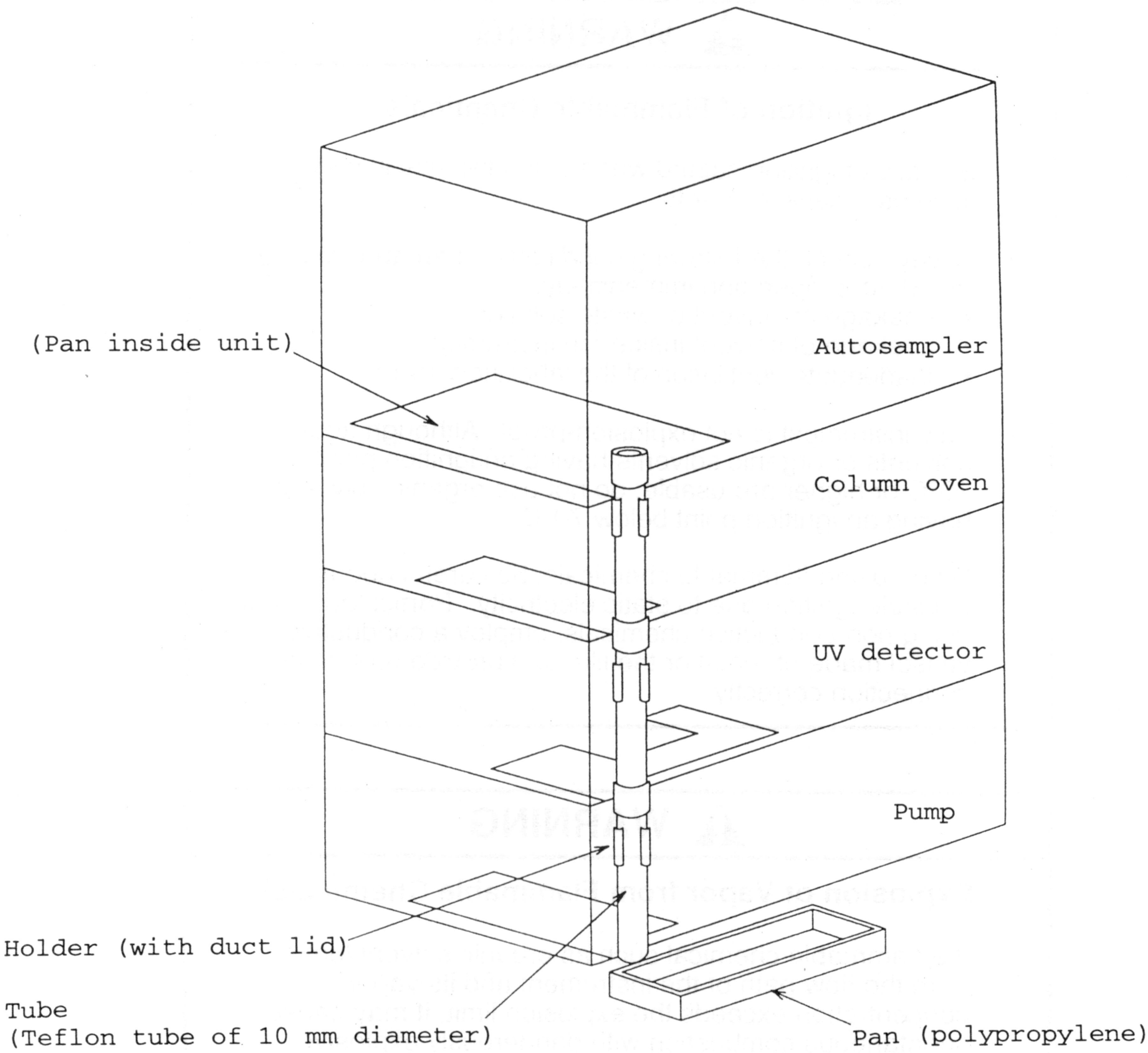


Fig. 11-1 Waste liquid tube set

12. DYNAMIC MIXER (OPTION)

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12. DYNAMIC MIXER (OPTION)

12-1 Outline

This mixer is used to enhance the mixing accuracy of two or more mobile phases through forcible stirring and thereby stabilize the baseline. It is combined with a high pressure gradient system or low pressure gradient system. Refer to **section 3-7-2** for usage of the low pressure gradient system.

12-2 Specifications of Dynamic Mixer

(1)	Stirring method	:	With stirrer
(2)	Chamber capacity	:	About 2.0 mL (0.69 mL × 1, 0.65 mL × 2)
(3)	Rotational speed	:	300 rpm (fixed)
(4)	Withstand pressure	:	34 MPa (350 kg/cm^2)
(5)	Maximum working flow	:	9.999 mL/min
(6)	Recommended working flow range	:	0.1 to 9.999 mL/min
(7)	Rating	:	12 V DC, 0.5 A
(8)	Dimensions	:	65(W) × 42(D) × 93(H) mm

12-3 Installation of Dynamic Mixer

> **⚠ WARNING**
>
> **Beware of Electric Shock !**
>
> Before removing the instrument cover for parts replacement, etc., be sure to turn OFF the power switch and disconnect the power cord from the receptacle.

A high pressure gradient system should be installed referring to 2-2-3. Installation of a low pressure gradient system is explained here. For installation, detach the right side panel of Model L-7100 pump, mount the dynamic mixer in the proportioning valve case and connect pipes and wires as detailed below.

12-3-1 Mounting of Dynamic Mixer

Fix the mixer by two screws furnished so that the lead wire faces the rear.

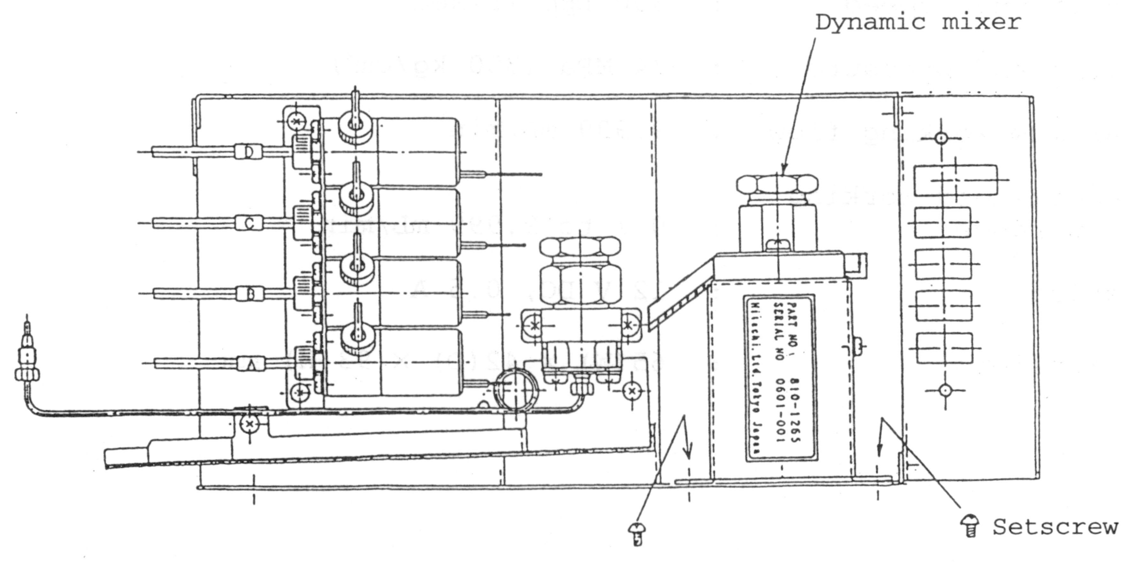

Fig. 12-1 Mounting of Dynamic Mixer

12-3-2 Wiring of Dynamic Mixer

⚠ WARNING
Ground Properly to Prevent Electric Shock Hazard!
• Be sure to use the power cable supplied with the instrument. Use of a different power cable may result in an electric shock hazard.
• This instrument is classified as “1” in IEC1010-1 Annex H and “plug-connected type” in IEC1010-1, so connect the power cable to a grounding 3-wire outlet..
• If a grounded 3-wire outlet is not available, then be sure to provide proper grounding connection.

Connect the dynamic mixer connector to 6P connector of the gradient casing via the MIX SO board (810-7004).

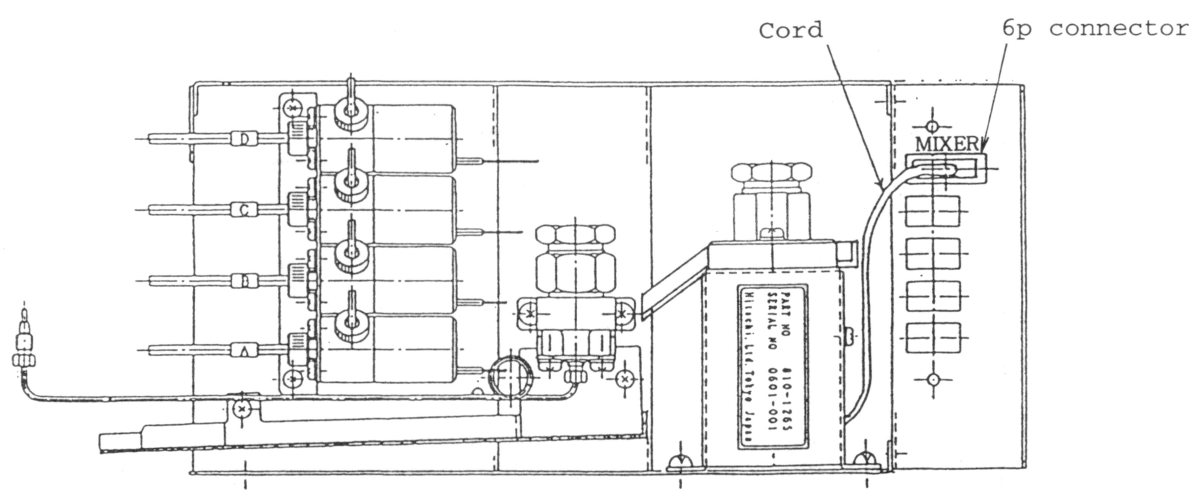

Fig. 12-2 Wiring of Dynamic Mixer

12-3-3 Piping of Dynamic Mixer

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

In a low pressure gradient system, the dynamic mixer is used alone or in combination with the static mixer. For usage, refer to **3-7-2**.

(1) When using the dynamic mixer alone:

(a) Disconnect the SUS pipe from between the drain valve and static mixer.

(b) Connect the furnished SUS pipe between the drain valve and the inlet port of dynamic mixer.

(c) Connect the outlet port of dynamic mixer to the manual injector or autosampler by the furnished SUS pipe (with connection nipple).

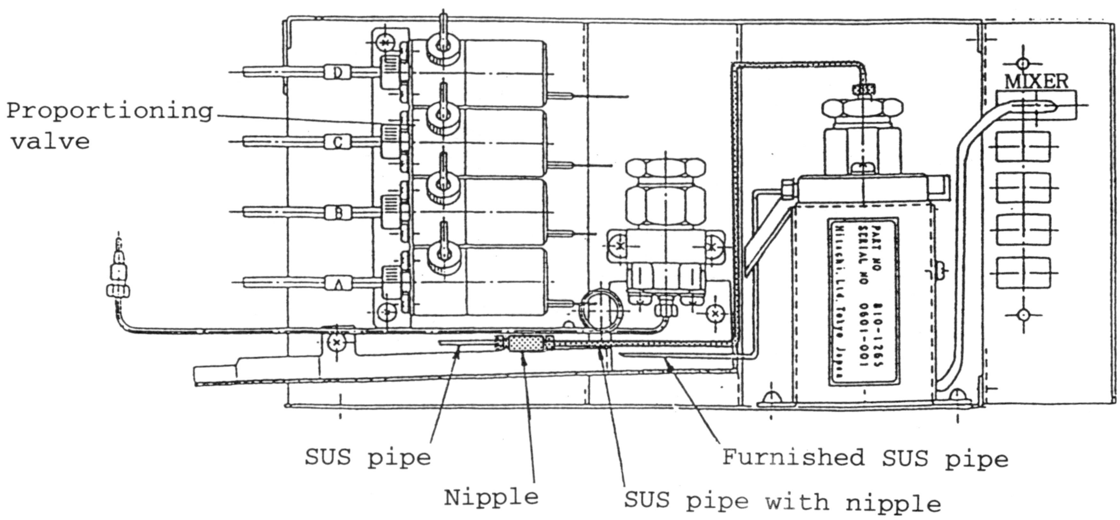

Fig. 12-3 Piping of Dynamic Mixer (1)

(2) When using the dynamic mixer in connection with static mixer:

(a) Remove the nipple from the furnished SUS pipe (with connection nipple), and connect the pipe between the static mixer outlet and the dynamic mixer inlet.

(b) Connect the outlet port of dynamic mixer to the manual injector or autosampler by the furnished SUS pipe (without connection nipple).

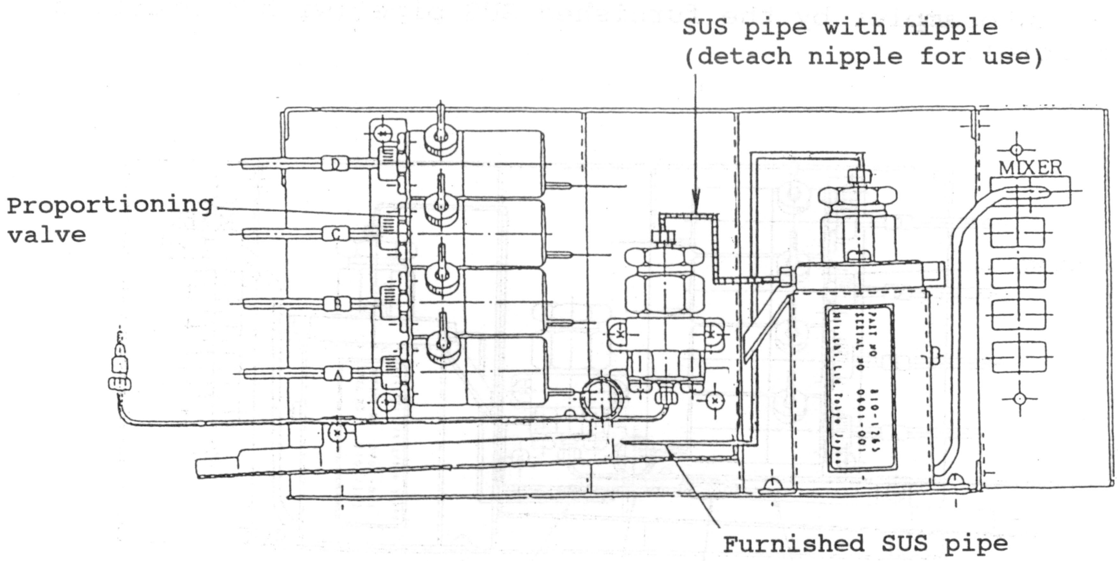

Fig. 12-4 Piping of Dynamic Mixer (2)

12-4 Operation

(1) Turn on the POWER switch of Model L-7100 and press the PUMP ON switch. The motor of dynamic mixer will start and the stirrer in chamber will rotate.

(2) Before connecting the pipe to the injector side, fill the chamber with liquid in order to purge air bubbles from inside the chamber.

(3) Make sure liquid is not leaking through each pipe.

13. PUMP SEAL WASHING SYSTEM (OPTION)

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13. PUMP SEAL WASHING SYSTEM (OPTION)

⚠ WARNING

Ignition of Flammable Chemicals!

- Beware of ignition hazard when using flammable chemicals such as organic solvents.
- Always check the following conditions. If an abnormality is found, stop operation immediately.
  - Leakage of solvent or waste solution
  - Leakage of solvent inside the instrument
  - Inadequate ventilation of the laboratory room
- This instrument is not explosion-proof. Although aqueous solvents or organic solvents having an ignition point of 70°C or higher are usable, do not use organic solvents having an ignition point below 70°C.
- When using flammable chemicals, be careful about possible ignition due to static electricity. Particularly when using non-conductive chemicals, employ a conductive vessel made of metal or the like and provide grounding connection correctly.

⚠ WARNING

Explosion of Vapor from Flammable Chemicals!

- If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration exceeds the explosion limit, it may cause spontaneous combustion with dangerously explosive results.
- When using a flammable and readily volatile chemical, be sure to check for leakage from the instrument flow path and ventilate the laboratory room adequately.

13-1 Introduction

If washing is not performed thoroughly with distilled water after the use of buffer solutions or solvents having a high salt concentration, crystals will form on the plunger and hasten the wear of the pump seal and/or plunger. This system is intended for washing the rear part of the pump seal and the plunger in order to alleviate wear due to the crystals.

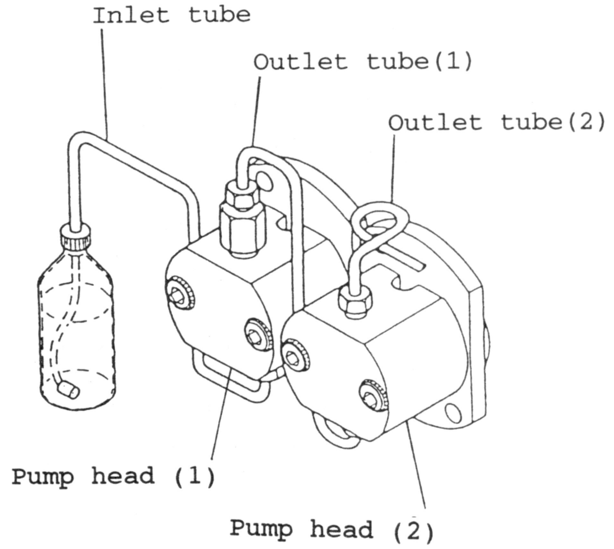
Besides the usual type of system which is operated manually, it is connectable with the L-7200/L-7250 autosampler for automatic washing of the pump seal.

This manual describes the installation and maintenance of the washing system. For the usage and maintenance of the L-7200/L-7250 autosampler, refer to **their respective instruction manuals.**

13-2 Assembly of Washing System

13-2-1 Removal of Pump Head

Remove the pump head in the following procedure.

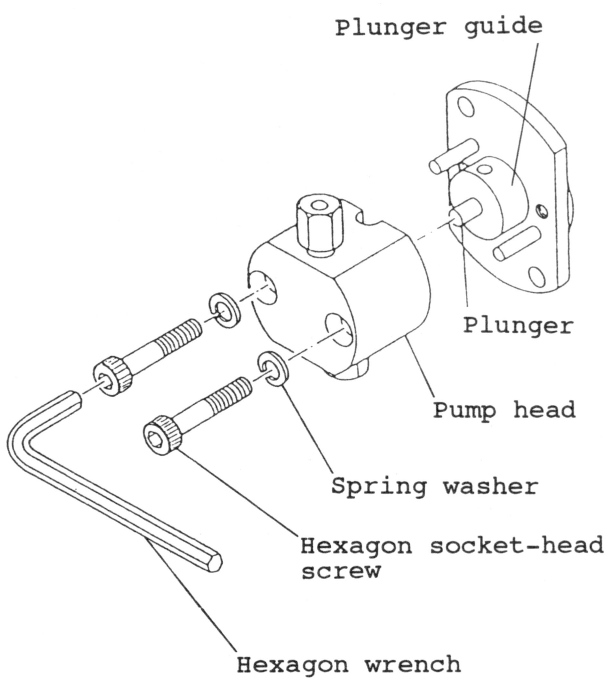


(1) Detach the inlet tube and outlet tubes (1) and (2) from the pump head.

(2) Loosen and remove the hexagon socket-head screws from the pump head using the hexagon wrench.

(3) Carefully pull the pump head forward and out using both hands. (Both pump heads (1) and (2))

NOTICE:	Be careful not to break the plunger.

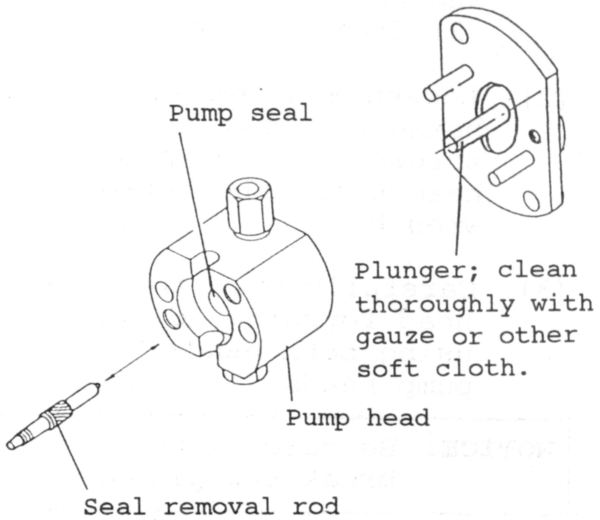


(4) Carefully pull the plunger guide forward and out. (For both pump heads (1) and (2))

NOTICE:	Do not remove the seal inside the plunger guide.

13-2-2 Replacement of Pump Seal

NOTICE:	This section pertains to when the pump seal washing system is attached later to an already operating pump, and no particular procedure is necessary at attachment when the system and pump will be started simultaneously.

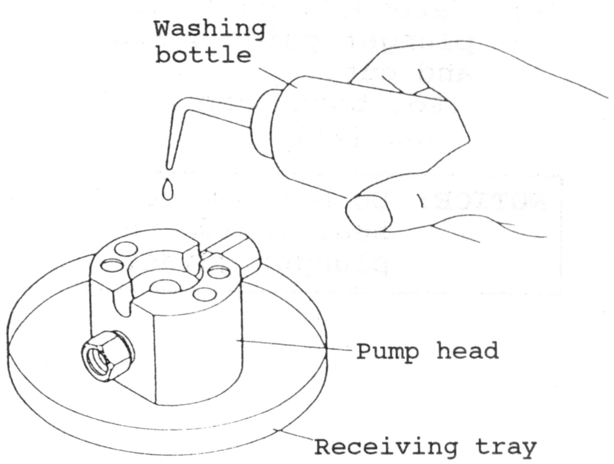


(1) Remove the pump seal.

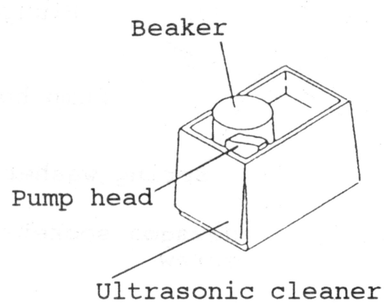
a) When a pump seal remains in the pump head, pull it out by screwing a seal removing rod into the pump seal.

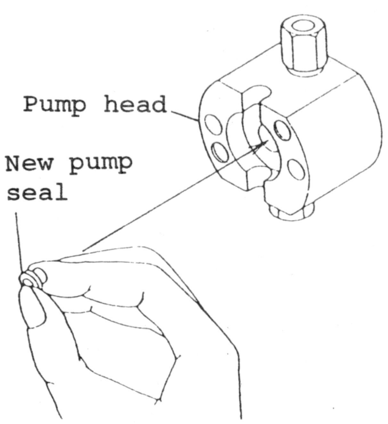
b) If a pump seal remains in the plunger, start the pump and, as soon as the plunger has come out, stop the pump and pull out the seal.

c) Wipe the plunger thoroughly with gauze or other soft cloth.



(2) Wash the pump head thoroughly with distilled water or organic solvent or, depending on the case, with neutral detergent or an ultrasonic cleaner.



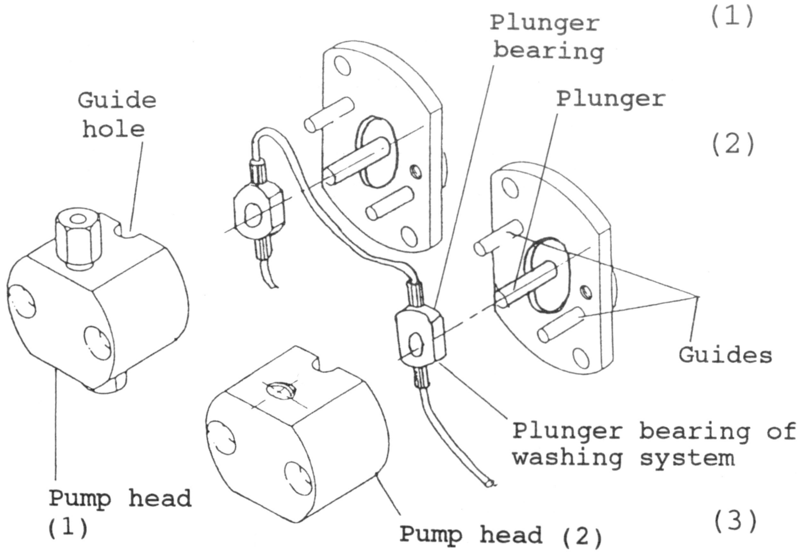


(3) Mount a new pump seal on the pump head.

NOTICE:	Do not remove the seal attached to the plunger guide.

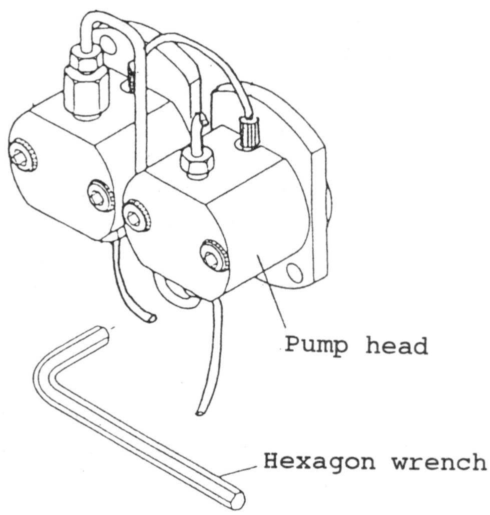
13-2-3 Attachment of Pump Seal Washing System

Attach the pump seal washing system in the following procedure.



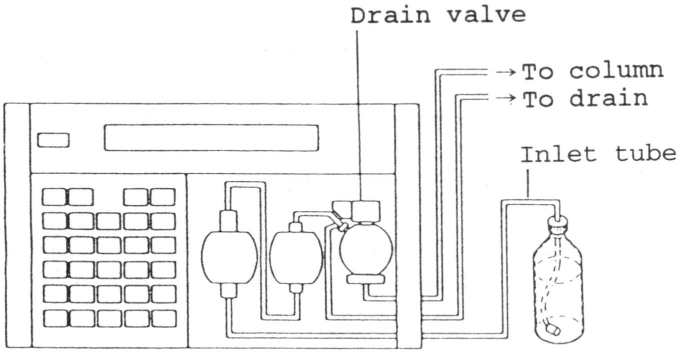
(1) Insert the plunger bearing of the washing system into the plunger.

(2) Insert the pump heads (1) and (2) gently into the guides.



(3) Fasten the pump heads. Attach the heads in place. First tighten the hexagon socket-head screws lightly with the hexagon wrench, then tighten alternately the left and right screws, about 30° at a time, with the wrench 4 to 5 times (absolutely avoid tightening fully on one side).

> **NOTICE:** A new seal may loosen gradually during use and allow liquid leakage. In this case retighten with the wrench as mentioned above.

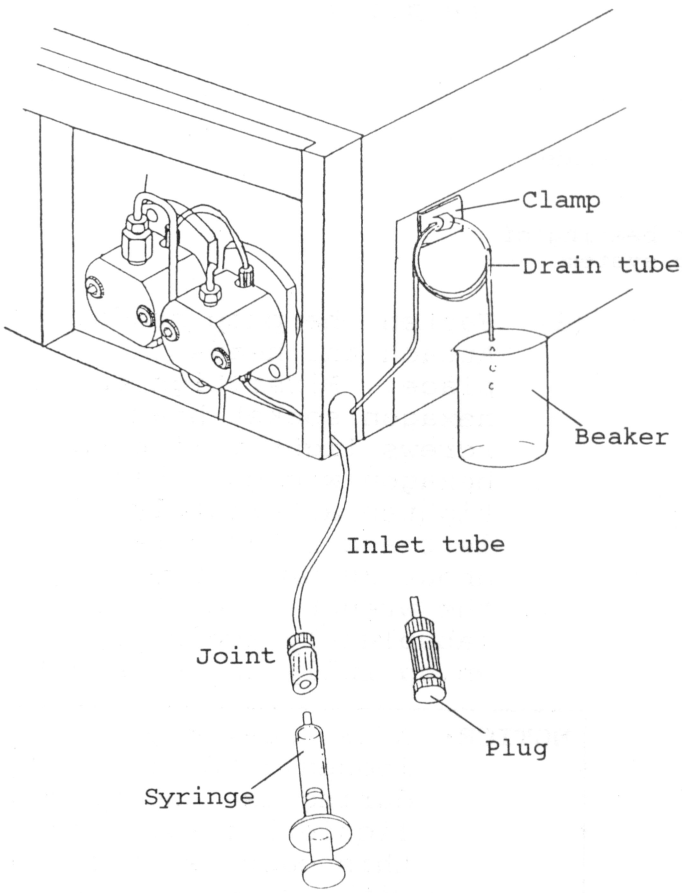


(4) When replacement of pump seal is finished, attach tubes in the reverse order of removal. Then with the drain valve open, start the pump to discharge air bubbles from the pump head and tube, and fill the pump with mobile phase.

13-3 Piping and Usage

13-3-1 In Case of Manual Washing

In the manual washing, the washing solution (distilled water) is injected into the washing loop using the furnished syringe (5 mL).



(1) Put the drain tube into a drain bottle (beaker or the like). The beaker should be placed on the desk. Fix the drain tube to the pump side using the furnished clamp so the tube end will not bend.

> **NOTICE:**
> Be careful about the end position of drain tube since liquid leakage cannot be confirmed if the tube end contacts the liquid surface.

(2) Fill the flow path of the washing system with the washing solution (distilled water). Prepare a proper amount of solution with the furnished syringe (5 mL).

(3) Connect the syringe to the joint of the inlet tube and inject the solution.

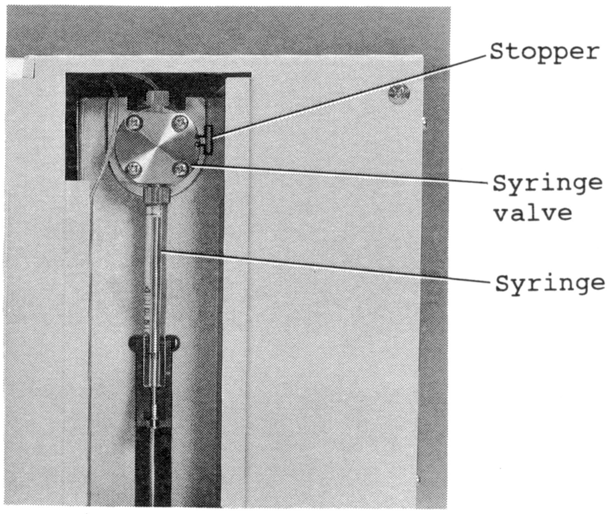
(4) Inject solution until the flow path of the washing system is filled with it (bubbles are eliminated).

(5) Detach the syringe from the joint and plug the end quickly.

(6) Set an empty drain bottle (beaker or the like) in place.

13-3-2 In Case of Automatic Washing

Automatic washing can be made using the washing solution of the L-7200/L-7250 autosampler. For the operating method, refer to **section 2-3 in the instruction manual for the L-7200 autosampler or section 2-3 in the instruction manual for the L-7250 autosampler (sequential mode analytical operation)**.



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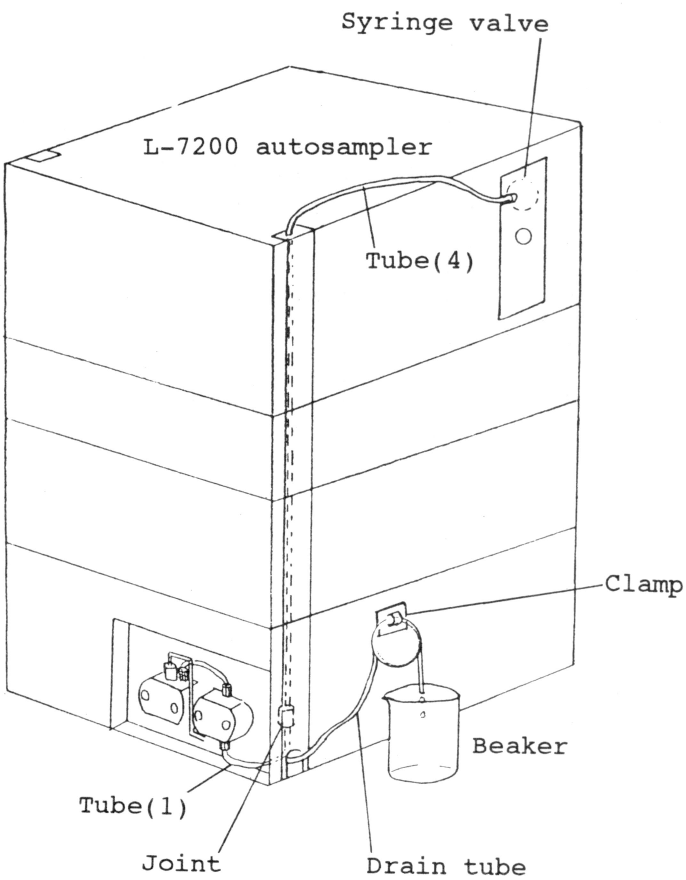


(1) Detach the stopper of the syringe valve on L-7200/L-7250 and connect the furnished tube (4).

(2) Connect the joint of tube (1) with tube (4). Run tube (4) through the duct of each unit.

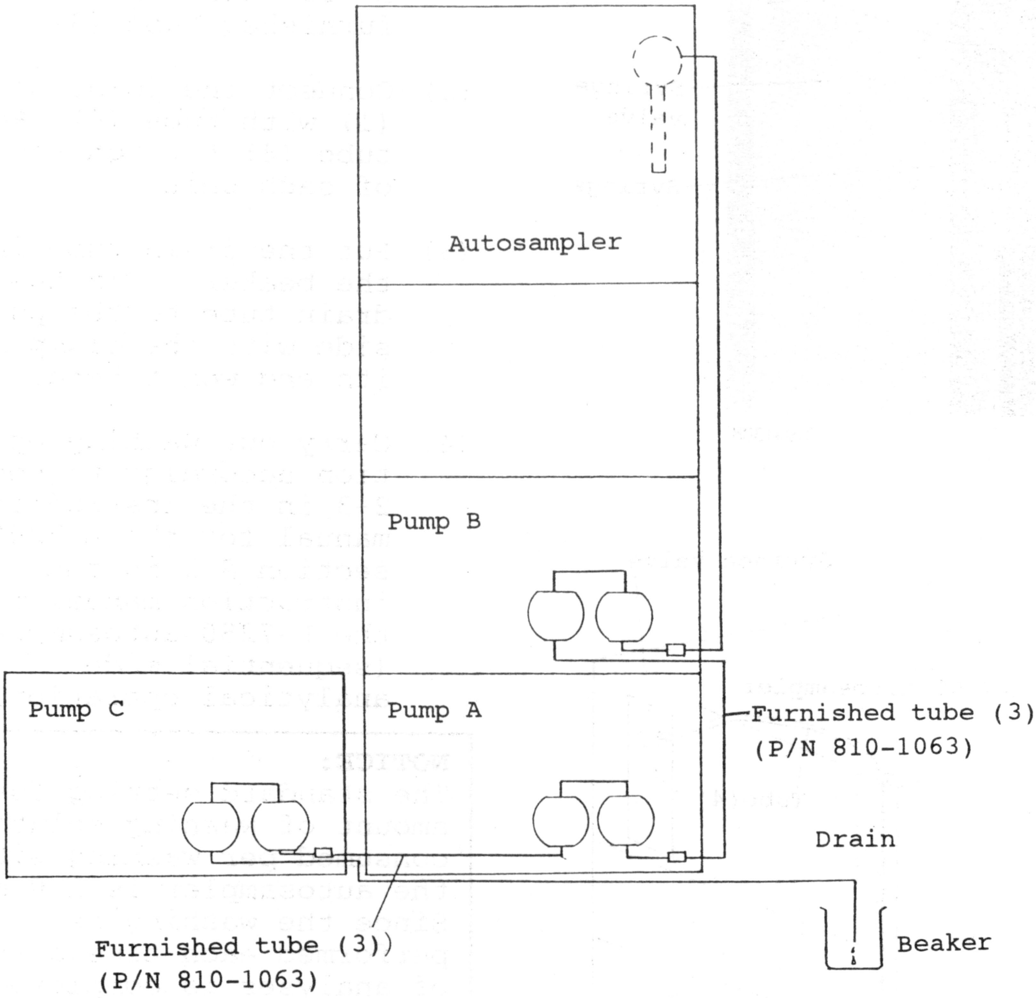
(3) Put the drain tube into the beaker. Fix the drain tube to the pump side with the clamp so its end won't bend.

(4) Carry out washing operation according to section 2-3 in the instruction manual for the L-7200 or section 2-3 in the instruction manual for the L-7250 autosampler (sequential mode analytical operation).

NOTICE:
The standard setting for the amount of washing solution consumed per washing with the autosampler is 1.0 mL. Since the washing is performed each time a series of analyses is completed ("ALL END" is indicated on the autosampler), prepare a beaker which is large enough to hold the drained solution.

13-3-3 When Using Multiple Seal Washing Systems

When using multiple seal washing systems in a two or three-liquid high pressure gradient system or the like and performing automatic washing with a single autosampler, carry out piping as described below. Use the furnished tube (3) (P/N 810-1063) for piping between the pumps. Use the same procedure for manual washing.



13-4 Maintenance and Inspection

13-4-1 Periodical Inspection

Although the seal washing system is built to withstand usage under certain specific conditions, some parts will deteriorate with time and require replacement.

No.	Check Item	Frequency	Check Method
1	Leakage of pump washing solution	Daily	Check if the washing system is filled with wash solution, and if there are any bubbles in the solution. If solution overflows from the system, replace the pump seal as explained in 13-4-2 (2).
2	Liquid leakage from flow path	Daily	Check the pipes and connecting parts, and retighten any leaking part or replace the seal. If a check valve is leaking, retighten the valve. If there is still leakage, then replace the valve packing with reference to 7-6-6.
3	Pressure at analysis or pressure fluctuation	Weekly, at routine analysis	Check if the baseline fluctuates. If it fluctuates, check the flow path, column, etc.
4	Cleaning of flow path	When contamination appears	If contamination appears, wash out the flow path between inlet tube and sample injector for about 30 minutes using water or isopropanol.
5	Pump seal replacement	Every 4 months	Refer to section 13-4-2 (2).

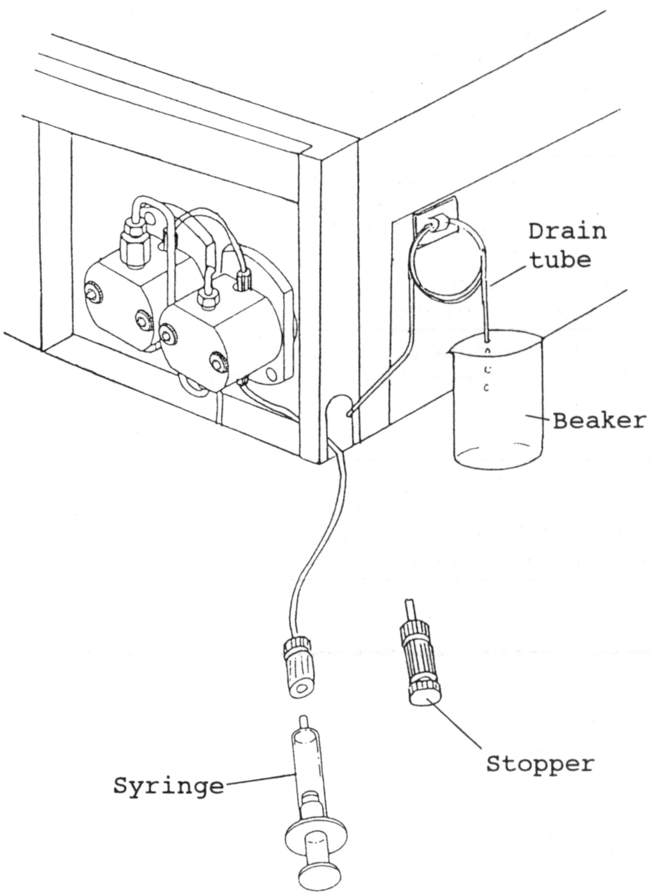
13-4-2 Maintenance and Inspection Method

NOTICE: For usage of an ultrasonic cleaner or the like, refer to their respective instruction manuals.

(1) Replenishment of Pump Seal Washing Solution

Articles to be prepared

- Syringe (5 mL)
- Beaker
- Washing solution bottle (distilled water)



Fill the loop of the washing system connected to the pump head with washing solution.

(a) Set the beaker beneath the drain tube end.

(b) Aspirate distilled water into the syringe (standard-equipped).

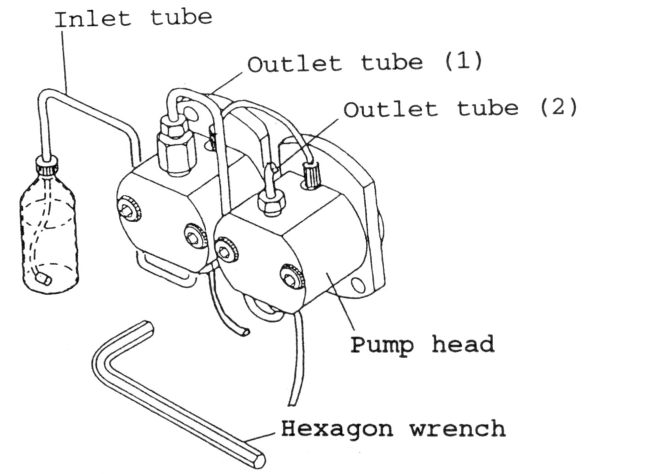
(c) Remove the stopper, and inject washing solution through the solution inlet.

(d) Fill the loop with solution so that no bubbles remain, and pull out the syringe.

(e) Quickly attach the stopper.

NOTICE: Note that liquid leakage will not be detectable if the end of the drain tube touches the water surface. So set an empty beaker in place and check every day whether there is any leakage.

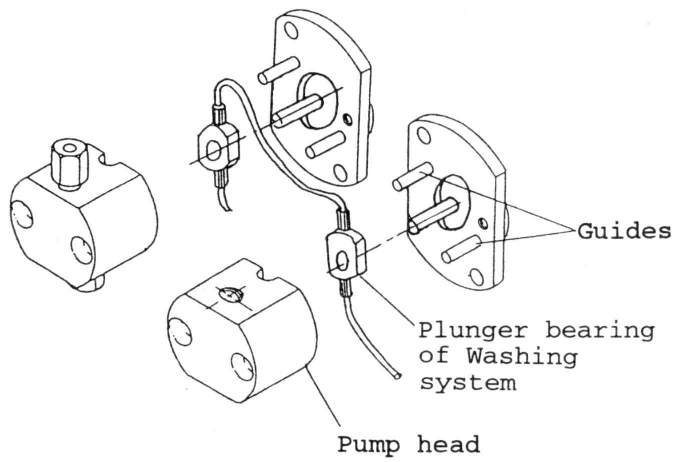
(2) Pump Seal Replacement



Articles to be prepared

- Wrench • Hexagon wrench
- Pump seal(large, small), 2 pcs
- Washing solution bottle
- Ultrasonic cleaner
- Seal removing rod
- Soft cloth
- Blade-edged screwdriver
- Receiving tray
- Beaker
- Seal attaching rod

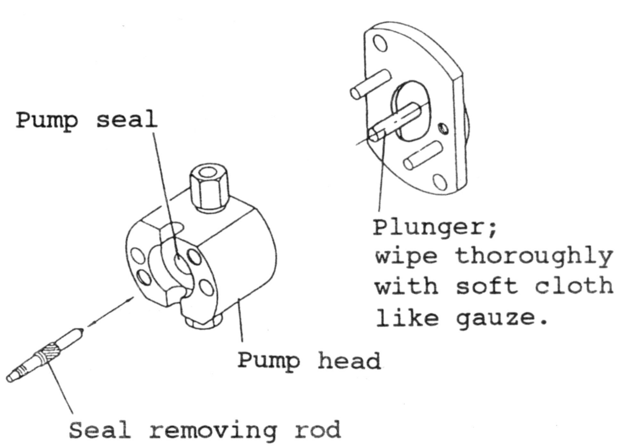
(a) Remove the inlet tube and outlet tubes (1) and (2) connected to the pump head.



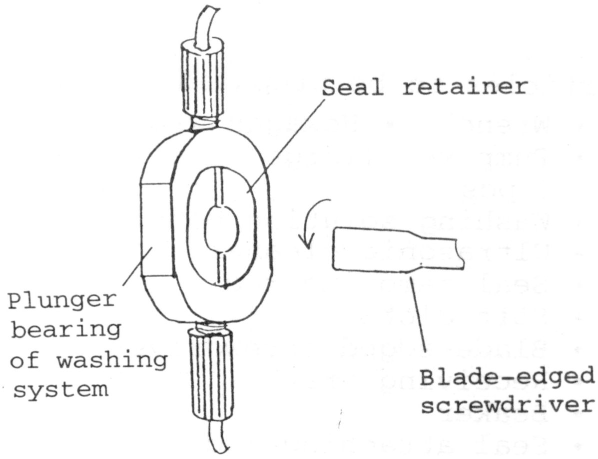
(b) Loosen alternately and remove the hexagon socket-head screws on the pump head using the hexagon wrench.

(c) Carefully pull the pump head forward and out using both hands.

(d) Remove the large pump seal located between pump head and plunger bearing of washing system.
  i) If a large pump seal remains in the pump head, pull it out by screwing a seal removing rod into the seal.
  ii) If a large pump seal remains in the plunger, remove it together with the seal house of washer.

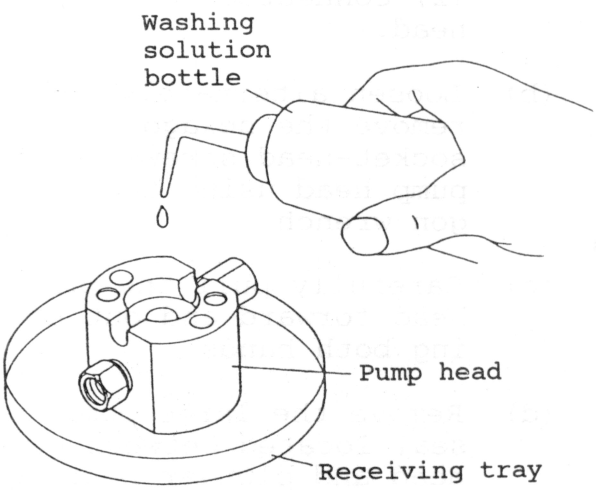


(e) Next remove the small pump seal from plunger bearing of washing system. The plunger bearing is removable from the plunger while slightly turning the seal house to the left and right.



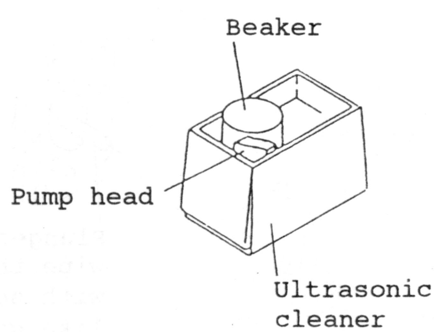
(f) Hold the plunger bearing of the washing system with a wrench (17) and loosen and remove the seal retainer with a blade-edged screwdriver.

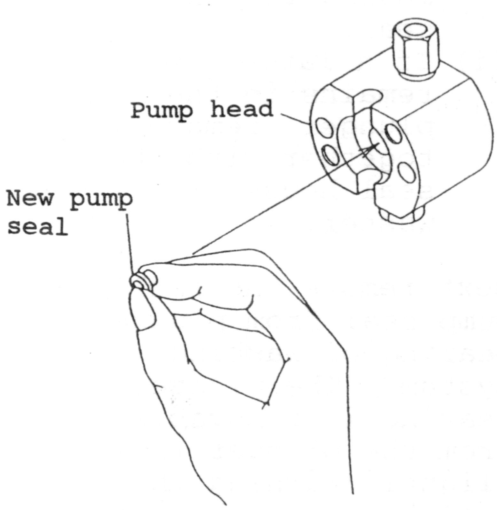
(g) Remove the small pump seal between plunger bearing and seal retainer.
If a small pump seal remains in the bearing, insert the seal removing rod and remove it.



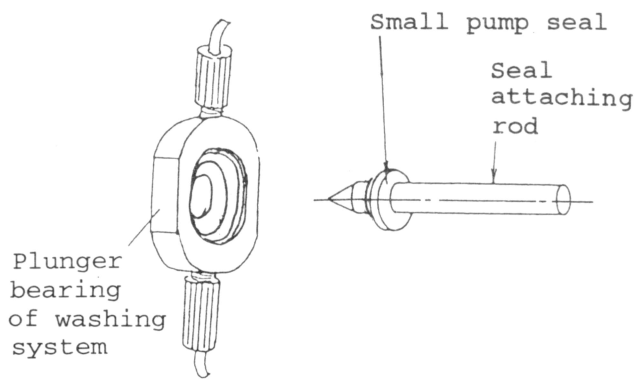
(h) Clean the pump head.
Wash the pump head thoroughly with distilled water or organic solvent or, depending on the case, with neutral detergent or an ultrasonic cleaner.
If salt crystals or the like have adhered, either wipe thoroughly or wash with a neutral detergent or an ultrasonic cleaner.

(i) Wipe the plunger with gauze or other soft cloth.

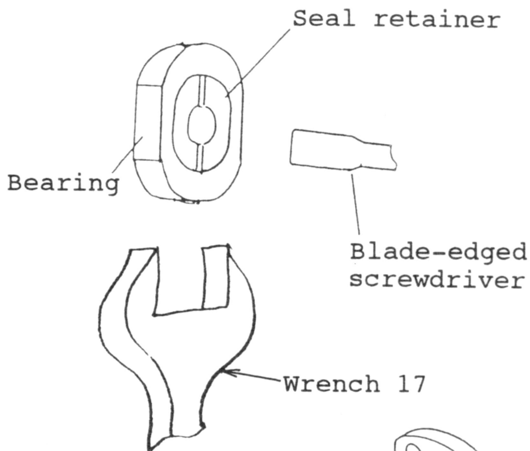




(j) Attach a new pump seal to the pump head.

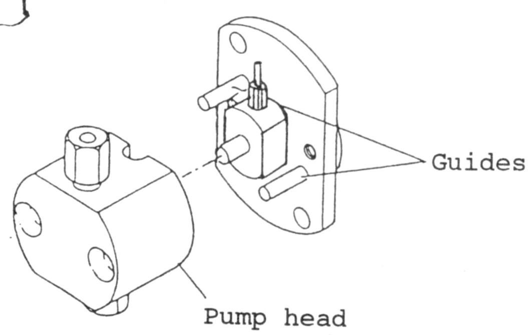


(k) Fit a new pump seal (small) on the seal attaching rod, and insert it into the plunger bearing of the washing system.



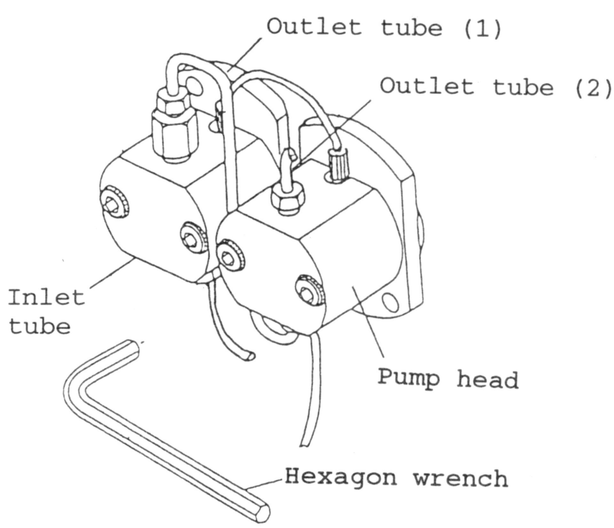
(l) Tighten the seal retainer firmly with the wrench and blade-edged screwdriver.

(m) Align the plunger bearing of washing system with the plunger and insert gently while turning from left to right.



(n) Attach the pump head to the pump.
Align the pump head with the guides and insert gently.

(o) Fasten the pump head.
Put on the spring washers and hexagon socket-head screws. Tighten these screws all the way by hand and then, with the wrench, tighten the right and left ones alternately about 30° at a time, 4 to 5 times. (One-sided tightening is not allowed.)



(p) Open the drain valve and start the pump, and fill the flow path up to the drain valve with mobile phase so as to expel bubbles.

(q) Fill the washing system with distilled water.

NOTICE:
In the case of a new seal, it may gradually loosen during use and allow liquid leakage. In such case it should be retightened with the wrench as mentioned before.

Standard Operating Procedure
SOP

Title: Testing the function and specifications of the HPLC pump L-7100

Valid since: 21. 2. 1996

This SOP replaces the version of: 1. 7. 1994

Policy: Establish the reliable function of the L-7100

Field of application:

Responsibility: Laboratory Manager

	Date / signature	Copy received by:
Written:	....	☐ Testing Facility Manager ☐ Laboratory Manager ☐ Laboratory personnel ☐ QA department
Reviewed:	....	
Approved:	....	

Total number of pages: 10 and 1 page Test Report

References: Instruction Manual Model L-7100 Pump

Contents

1. Introduction

One of the factors which influence the precision of a particular HPLC analysis is the flow rate constancy of the mobile phase. Fluctuating flow influences the area of individual peaks and leads to inaccurate results.

If the flow rate is higher or lower than that specified in the method, the retention times of the analytes will differ. These flow rate variations will result in the substances not being properly identified.

The composition of the mobile phase can be determined and varied via the gradient function in the L-7100 pump. It has a strong influence on the retention times of the analytes. Therefore, the mobile phase composition must be formed accurately and reproducibly.

For these reasons, it is important for the pump and gradient former to be tested at regular intervals. This Standard Operating Procedure (SOP) describes the respective tests.

If the tests determine that the pump does not conform to specifications, it should be taken out of service, appropriately marked as defect, and not used until the cause of the problem has been identified and corrected (see also chapter 5).

2. Definition of the testing interval

The function and technical specifications should be tested on a routine basis at regular intervals. The testing interval should be defined depending on the intensity of use of the L-7100 HPLC pump according to the following recommendations:

Normal use over day up to 5 days per week : Every 6 months
Intense use day and night or more than 5 days per week: Every 3 months
Use with buffers or other salt solutions : Every 3 months

3. Necessary materials

- Mobile phase : water (HPLC grade)
  water + 0.1% acetone (HPLC grade, for the gradient test)

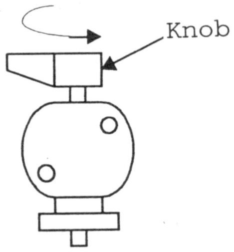
- Plug stopper for pump outlet
- Capillary (10 m, i.d. 0.25 mm) with fittings
- 5 ml volumetric flask
- Stop-watch
- Analytical balance
- UV detector
- Recorder, integrator or chromatography software for gradient test

4. Test procedure

4.1 Function test

Select the following pump parameters:
Mobile phase : water
Flow : 1 ml/min
Maximum pressure limit : 400 bar
Minimum pressure limit : 0 bar
Use channel A if the pump works in gradient mode

4.1.1 Pump function



Switch the pump power on. Insert the end of the inlet tube into the solvent bottle and open the drain valve.

PUMP ON/OFF | PURGE

Start the pumping and purging functions by pressing "PUMP ON/OFF" and "PURGE".

PURGE

Allow the pump to run until no more air bubbles exit from the outlet (about 1 minute). Stop the purging function by pressing "PURGE" again.

The pump will run considerably slower. It will now deliver with a flow rate of 1 ml/min and will emit a constant sound. The pitch of the sound will be much lower than when the purge function was switched on.

Set the flow rate to 5 mL/min. The pump now operates faster and will emit a higher pitch tone. Set the flow rate back to 1 mL/min.

Document the result in the "Test Report".

4.1.2 Zero pressure

After performing the previous test the pump is running at 1 mL/min with the drain valve open. Read the pressure indicated on the LC display: it should read 0 ± 1 bar.
Document the result in the "Test Report".

4.1.3 Minimum pressure limit

Select the following pump parameters :

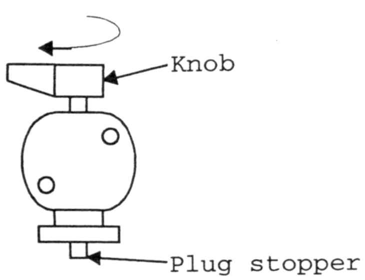
Mobile phase	:	water
Flow	:	1 ml/min
Minimum pressure limit	:	3 bar
Flow resistance	:	capillary (10 m, i.d. 0.25 mm)

After completing test 4.1.2, the pump delivers 1 mL/min at about 0 bar. Stop the pump by pressing "PUMP ON/OFF". Set the MIN pressure limit to 3 bar. Close the drain valve. Connect a capillary (10m, i.d. 0.25 mm) to the pump or mixer outlet in order to create a backpressure at least 2 bar bigger than the set MIN pressure limit. Start the pump with the "PUMP ON/OFF" key. As soon as a backpressure of at least 5 bar is indicated, open the drain valve. The pressure decreases to 0 bar.
The pump should switch itself off after 10 seconds.
Document the result in the "Test Report".

4.1.4 Maximum pressure limit 400 bar

Select the following pump parameters :

Mobile phase	:	water
Flow	:	0.2 ml/min
Maximum pressure limit	:	400 bar



Close off the drain valve and insert a plug stopper into the pump or mixer outlet.

Start the pump with "PUMP ON/OFF" key.

The pressure increases gradually. The pump should switch itself off once it reaches 400 bar.
Document the result in the "Test Report".

> **NOTICE:** In some cases, the pressure will drop rapidly due to a backward moving of the plunger at a certain cam position. If this occurs open the drain valve and repeat the test.

4.1.5 Leak rate

CL

After the pump has switched itself off in test 4.1.4, press the CLEAR key.

The pressure decreases gradually. Read the pressure indication on the LC display 5 minutes after pump switch off. It should read at least 300 bar.
Document the result in the test report.

4.2 Specification test

4.2.1 Flow accuracy

Select the following pump parameters :

Mobile phase	:	water
Flow	:	1.000 ml/min
Flow resistance	:	capillary (10 m,i.d. 0.25 mm)

Connect the capillary (10 m,i.d. 0.25 mm) to the pump or mixer outlet. Close the drain valve. The mobile phase flowing out of the capillary is used for the determination of the flow accuracy.

Start the pump with the "PUMP ON/OFF" key and wait until no air bubbles exit from the system any more. Ensure that no air bubbles are sucked in with the inlet tube. Determine the weight of the empty 5 ml volumetric flask. Put the volumetric flask under the outlet of the capillary and start the stop-watch at the same time. Collect the outflow for exactly 5 minutes and weigh the volumetric flask. It should contain 5.0 ± 0.1 g water. Document the result in the "Test Report".

4.2.2 Gradient accuracy

The described test can be used both for the low-pressure and high-pressure gradient systems.

Test conditions:

Mobile phase A : Water, degassed, 100%

Mobile phase B : Water + 0.1% acetone, degassed

Column : 10 m capillary i.d. 0.25 mm

Detector : UV, 250 nm

Range : 0.1 AUFS, or corresponding value at data system

Low-pressure gradient type : Slow

Gradient table:

LOW PRESSURE GRADIENT

TIME	%A	%B	%C	%D	FLOW
0.0	100	0	0	0	1,000
0.1	90	10	0	0	
10.0	90	10	0	0	
10.1	50	50	0	0	
20.0	50	50	0	0	
20.1	10	90	0	0	
30.0	10	90	0	0	
30.1	0	100	0	0	
40.0	0	100	0	0	
40.1	100	0	0	0	

HIGH PRESSURE GRADIENT

TIME	%A	%B	%C	%D	FLOW
0.0	100	0	0	0	1,000
0.1	90	10	0	0	
20.0	90	10	0	0	
20.1	50	50	0	0	
40.0	50	50	0	0	
40.1	10	90	0	0	
60.0	10	90	0	0	
60.1	0	100	0	0	
80.0	0	100	0	0	
80.1	100	0	0	0	

Preparation :

Replace the column with a restriction capillary for the test. This enables the pump to create the necessary pressure and simulates the conditions that would exist when using a column. We recommend a capillary of approximately 10 m in length and 0.25 mm in internal diameter. You need to degas using the degasser.

Thoroughly remove all air bubbles from the gradient system. Then select the initial conditions of the gradient program (100%A, 1 ml/min) and wait until the detector baseline is stable.

Test :

Start the gradient program with the START/STOP key and at the same time start the acquisition with a recorder, integrator or chromatography software. The chart speed should be set to approximately 1 cm/min, the signal height for 0%B should be approximately 10% and for 100%B approximately 90% of the chart width.

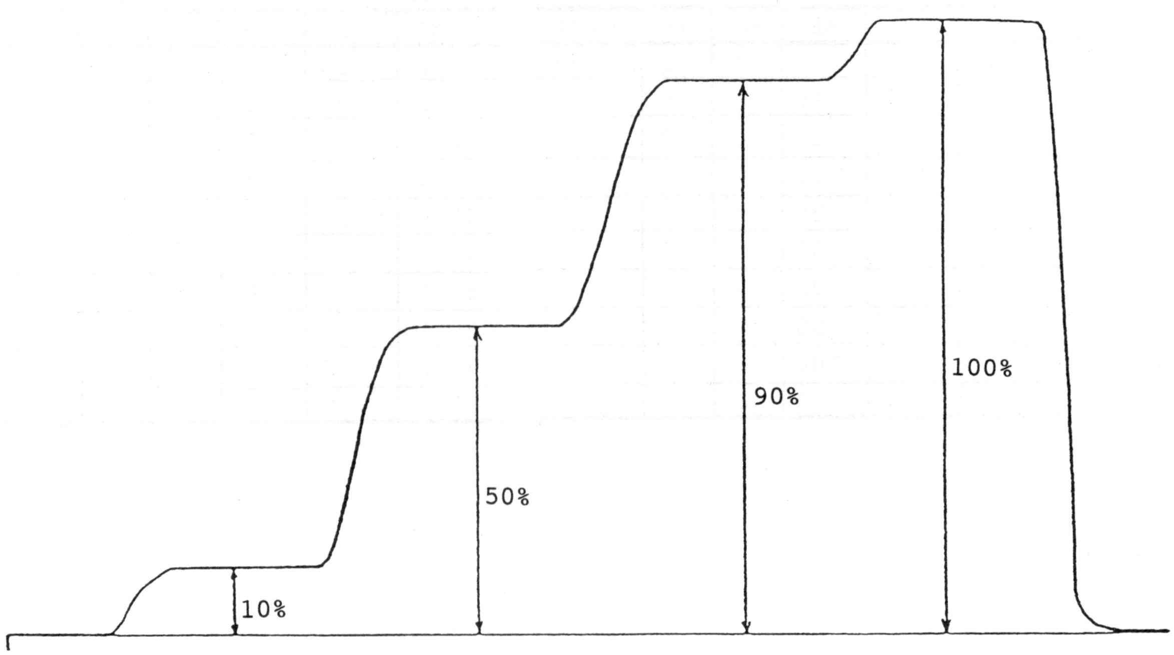


Fig. 1 Result of the gradient test

Data processing :

The graph should have a clearly defined horizontal plateau at each of the gradient steps (see Fig. 1). The height of the various plateaus must correspond to the programmed %B values of the mobile phase composition. Draw the baseline at 0%B and measure the height Hx of the respective plateaus in mm. The really obtained mobile phase compositions Cx (in %B) can be calculated from the Hx values by the following formula :

$$Cx = \frac{Hx}{H_{100}} \times 100(\%)$$

where x stands for the programmed step height (10%, 50%, 90% and 100%) H_{100} is the step height of the 100%B step in mm. Determine the mobile phase composition obtained for the 10%, 50% and 90% step.

The following specifications should be fulfilled :
Low-pressure gradient system : maximum deviation $\pm$1%
High-pressure gradient system : maximum deviation $\pm$3%
Document the results in the "Test Report".
The channels C and D - if used - have to be tested in the same way. Change the applied gradient program accordingly.
Document the result in the "Test Report".

5. Documentation and archiving

The results of every test should be entered in the "Test Report".

Add the instrument number, test date, date of next test, and the name of the tester. Then the test report is filed chronologically in the instrument logbook.

If the instrument meets the specifications, affix a corresponding label (e.g. in green color) to the instrument indicating the instrument number, the date of the test, the date of next test, and the name of the tester.

If the instrument does not meet specifications, affix a corresponding label (e.g.in red color with the lettering "DEFECT") to the instrument indicating the instrument number, the date of the test, the date of the next test and the name of the tester. The instrument may not be used until it has been properly serviced and shown to meet the specifications.

All documents on instrument tests, i.e. standard operating procedures and test reports must be archived according to the regulations of the respective QA system.

Operating instructions, service documentation, and the spare parts lists are archived at the manufacturer and are available for reference.

		Test Report	Page 1 of 1

Module	Pump
Model	L-7100
Instrument number	

Function test

No.	Item tested	Setting	Specification	Result
1	Delivery function	Switch from purge to 1 ml/flow	Flow rate will become considerably slower, pump motor turns slower	
		Switch from 1 ml/min to 5 ml/min	Flow rate will become considerably faster, pump motor turns faster	
2	Zero pressure indication	Open drain valve while pump is delivering	Pressure indication returns to 0 ± 1 bar	
3	Minimum pressure limit	Set to 3 bar, connect capillary, close drain valve, start pump, wait until pressure is at least 5 bar, open drain valve	Pressure indication returns to 0 bar, after 10 s pump switches itself off	
4	Maximum pressure limit	Set to 400 bar, flow rate 0.2 ml/min, insert plug stopper at pump or mixer outlet, start pump	When the pressure surpasses the maximum pressure limit the pump switches itself off	
5	Leak rate	Press CL key, observe pressure indication	After 5 minutes still a pressure of at least 300 bar is indicated	

Specification test

No.	Item tested	Setting	Specification	Result
1	Flow accuracy	Flow: 1.000 ml/min, pressure: $\geq$ 5 bar	5.0 ± 0.1 g	
2	Gradient accuracy	Gradient programme channel: A/B	Maximum deviation of step heights: low-pressure gr: ± 1%, high-pressure gr: ± 3%	
		Gradient programme channel: C/D	"	

Date of test: ______________________

Next test scheduled for: ______________________

Tested by: ______________________

Signature: ______________________

Components of your HPLC system

Please indicate all important information on your chromatography system. This serves for your reference in the case that you have any questions e.g. on the operation or if any problems occur.

Modules	Serial No./ Version	Installation date	Options/ Modifications

L-7100 logbook : Performance Tests, Maintenance, Service

Serial No. Inventory No.

Date	Action	Sign

Terminology

Check Valve	:	A valve that prevents reverse flow of mobile phase.
Column Flush	:	A function that automatically rinses out the column after the end of analysis.
Constant Flow Rate Mode	:	Mode in which mobile phase is fed at constant flow rate in single-liquid delivery system.
Constant Pressure Mode	:	Mode in which mobile phase is fed at constant pressure in single-liquid delivery system.
Degasser	:	A unit that removes air from mobile phase.
Degassing	:	Elimination of air dissolved in mobile phase.
D-line	:	A digital network exclusively for analysis.
Dynamic Mixer	:	Mixes multiple solvents in gradient mode. Rotates the stirrer to forcibly mix the solvents.
Error Message	:	Appears on display when instrument incurs a fault.
Event	:	A control code that outputs a signal via contacts.
Gradient	:	A mode in which analysis is performed while successively changing the composition of mobile phases.
Gradient Curve	:	A gradient curve obtained through the gradient program.
Gradient Program	:	A program that successively changes the composition of mobile phases.
High Pressure Gradient System	:	A mode in which analysis is performed while successively changing the composition of 2 or 3 mobile phases, using as many pumps as there are mobile phases.
Initialize	:	Initial setting of the instrument.
Initial Status	:	Programming mode status in which gradient program is not yet activated.
Injector	:	A unit that injects sample into column.
Key Lock	:	A function that disables keying on control panel.
Link Program	:	A function for successively executing multiple programs.
Logbook	:	A function for displaying maintenance data on the instrument.

Low Pressure Gradient System : A mode in which analysis is performed while successively changing the composition of 2 to 4 mobile phases, using a single pump.

Manual Operation : An operation mode in which liquid is delivered under constant conditions.

Monitor Screen : A main screen that displays pressure, flow rate, status, etc.

Pressure Monitor : Displays the number of pressure errors.

Programming Operation : An operation mode using a gradient.

Proportioning Valve : A valve that determines the mixing ratio of solvents in low pressure gradient mode.

Pump A : The main pump (or 1st pump) that carries out control when two or more pumps are connected in system.

Pump B, C : Pumps that are controlledwhen two or more pumps are connected in system.

Purge : Status in which mobile phase is fed at maximum flow rate.

Single-liquid Delivery Mode : Mode in which a single liquid is delivered by a single pump.

Solenoid Valve : Valves that are used as proportioning valves.

Static Mixer : Mixes multiple solvents in low pressure gradient mode. Glass beads contained in mixer serve to mix the solvents.

Utility : A function for setting operating parameters of the instrument.

Warming Up : Status in which instrument is warmed up after power on. A sufficient warmup is required for stable analysis.

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